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GUAM AGRICULTURAL EXPERIMENT STATION.

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE.

REPORT OF THE

GUAM AGRICULTURAL EXPERIMENT

STATION.

1921.

▼

Issued March, 1923.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM.

[Under the supervision of the States Relations Service, United States Department of Agriculture.]

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E. W. ALLEN, *Chief, Office of Experiment Stations.*

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PETER NELSON, *Assistant.*

LETTER OF TRANSMITTAL.

GUAM AGRICULTURAL EXPERIMENT STATION,
Island of Guam, March 30, 1922.

SIR: I have the honor to transmit herewith a report of the Guam Agricultural Experiment Station, 1921.

Very respectfully,

C. W. EDWARDS,
Animal Husbandman in Charge.

Dr. A. C. TRUE,
*Director, States Relations Service,
U. S. Department of Agriculture, Washington, D. C.*

Publication recommended.

A. C. TRUE, *Director.*

Publication authorized.

HENRY C. WALLACE, *Secretary of Agriculture.*

¹ Resigned, effective June 6, 1921.

² Resigned, effective Nov. 10, 1921.

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REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION, 1921.

REPORT OF THE ANIMAL HUSBANDMAN IN CHARGE.

By C. W. EDWARDS.

ANIMAL HUSBANDRY.

During the year the station continued its work of conducting herd management and feeding tests for the determination of suitable local feeds as substitutes for imported ones, improving the station breeds by the infusion of new blood, and of producing improved stock for local distribution.

HORSES.

Efforts were again directed toward the upgrading of the native ponies of the island by crossing them with the station pure-bred Morgan sire. Through a continuation of the plan whereby privately owned native mares are brought in to the station and kept until bred, a large number of the mares were either in foal at the end of the year or had produced offspring. The few older half-blood individuals indicate that the Morgan is well adapted for crossing with native stock of this class. The half-bloods seem equal to the native dams in hardiness, but the offspring from subsequent crosses need to receive better care and feed than they have received. The average Chamorro knows very little concerning the proper management of domestic animals, and he is slow to adopt up-to-date methods relative to the care, feeding, and breeding of stock, especially of improved stock. One of the great obstacles in the work of upgrading the native stock lies in the difficulty of teaching the rancher the necessity of giving his stock good care and careful management. Judging from appearances, however, it is thought that the Chamorros are using horses to a greater extent than they did in former years.

CATTLE.

With the exception of two cases of liver fluke (*Fasciola hepatica*) and one of lungworm (*Strongylus paradoxus*), the station cattle kept in good condition during the year. The rainfall was ample throughout the year and there was an abundance of green feed for the cattle as a result.

The increase in station cattle by birth during the year numbered 25 grade animals and one pure-bred Ayrshire.

In connection with the work of improving the privately owned stock of the island, the station loaned four grade bulls for service during the year, and bred a number of cows, which were brought in for the purpose, to the pure-bred sires.

The two young Ayrshire bulls which were imported last year have made good growth and development. (Pl. I, Fig. 1.) Owing to lack of funds for the keeping of a pure-bred bull at Cotot, it was necessary to continue the use of a grade bull as head of the herd at that place.

Cattle ticks.—One of the greatest obstacles to the work of upgrading the native cattle or maintaining pure-bred herds is the prevalence on the island of the common cattle tick (*Margaropus annulatus*). The presence of the tick-fever organism in the blood of pure-bred or high-grade cattle, even after they have acquired a so-called immunity or high resistance to the fever, is considered largely responsible for the deterioration in size and milking qualities of the animals. Observations on the grade animals indicate that the half-bloods (half Ayrshire and half native) are highly resistant to the tick-fever organism in that they show no abnormal temperature periods. On the whole they do not seem to show greater ill effects from the presence of the ticks than do the native cattle. The three-quarter bloods (three-fourths Ayrshire and one-fourth native), however, do not seem to be resistant, and some of the animals have shown fever periods and loss of flesh when heavily infested with the parasites.

A systematically conducted campaign will have to be carried on before the island is freed from the tick. Under present conditions neither this station nor the island government has the funds or the personnel for the organization and carrying on of such a campaign. The station is doing all the work possible, with the facilities and assistance available, to keep the tick under control by demonstrating the use of arsenical dips. A number of the farmers are showing increased interest in the matter of tick eradication, but the average Chamorro is reluctant to adopt new methods or practices.

Feeding tests.—Copra cake or copra-cake meal has been used to considerable extent as a feed both for breeding stock and for milk cows. In a number of instances the cake had to be fed in combination with grains before the animals would consume it in any quantity. When fed alone, the meal gave good results with growing stock and with dry cows in the few instances where it was readily eaten. As is usually the case in the station experiments, the number of animals on trial at any one time was so small that further tests will have to be carried on before any definite conclusions can be drawn from the experiment. In general, best results were obtained when the cake or meal was fed in combination with corn, oats, rice bran, and wheat bran. A combination of high-grade rice bran, corn, and copra meal gives promise as a satisfactory feed for dairy cattle in localities where these feeds can be purchased at a reasonable price. Growing stock, including two young imported bulls, made good gains when fed meal combined in equal parts with either oats or corn.

SWINE.

The Chamorro people are very fond of pork and the demand for swine is always greater than the supply. Although a number of the ranchers are interested in the work of raising swine, they do not seem to realize the necessity of using improved methods of care and management for the animals, and in many instances the pigs are either kept in small pens where they are inadequately sheltered, or are allowed to run at large and rustle for themselves.

The movable colony type of house and run (Pl. I, Fig. 2) is especially suitable to Guam, where the climate is warm the year round, fenced areas are few, and intestinal parasites in swine are troublesome. These houses will accommodate several weanlings, a sow and litter, or three or four growing pigs. When the houses are changed from place to place, pigs in them will have less chance of becoming infested with parasites than they would were they penned in permanent colonies. Through the boys' and girls' clubs and other agencies, demonstrations have been carried on to show the value of the movable colony house for swine and the advisability of using good feeds and improved feeding methods.

Owing to the scarcity and high price of the locally produced lard, the Chamorro prefers an animal of the extreme lard type conformation. Among the native pigs are the chabot or extreme lard type, the rangy or typical razorback type, and gradations between the two. On the whole, they are of poor conformation, slow in their rate of development, and inferior in size and quality of bone, showing decided weakness in the pasterns. The infusion of Berkshire blood produces a marked improvement in these respects. The extreme rangy type is of course objected to by the Chamorro swine grower, and although the chunky type is popular, it is as a rule, small in frame and of fine bone. A cross of the rangy type with the Berkshire results in an animal that more nearly approaches the desired lard type than does the native parent, and a cross between the chunky type and the Berkshire results in a progeny having a frame showing no objectionable degree of ranginess when it is properly developed.

Increased interest in swine raising is evident in the localities where the pure-bred boars were placed when they were introduced by the island government last February. Acting under the direction of and encouraged by the extension agent of the experiment station, the owners of these boars are breeding them to their sows and also to the sows of other ranchers in the community. Very few of the swine of the island were affected by disease during the year, and the industry as a whole made very satisfactory progress.

Observations on the above-referred to shipments of boars indicates that pigs of weanling age or thereabouts do not stand shipment from the States nearly so well as do the older animals. The native rancher feeds rations which, while they are fairly satisfactory for mature stock, are generally insufficient for the maintenance of growing animals, and as a result there are distributed over the island stunted stock which does not give the satisfaction given by the more mature animal. Unfortunately, present facilities do not permit of the station's keeping surplus breeding swine or cattle until they are at least half grown.

Owing to shy breeding among some of the grade sows and the deaths from kidney worms of two of the sows, work with the station's breeding herd was not so successful as it might have been. There was on hand at the close of the year, however, a small herd of very good type grade gilts which give promise as a foundation stock for the continuance of improved breeding work.

FEEDING EXPERIMENTS.

The number of pigs available at the time the experimental feeding work started was so small that the station found it necessary to borrow privately owned stock for the purpose. It is only in rare instances that such work can be conducted cooperatively at the farmer's ranch because of the close and constant supervision required.

Copra meal, rice bran, and Lima beans for growing pigs.—Four weanling grade pigs were placed on Para pasture, supplemented for a period of 94 days with a ration consisting of 300 pounds of copra meal (high fat content), 300 pounds of rice bran, and 200 pounds of cull dried Lima beans (cooked). The ration, doubtless due to its bulkiness, proved unsatisfactory. It was tried because some of the ranchers used approximately this proportion of bran and meal in combination with various kinds of beans as a ration for their swine.

Copra meal, rice, and beans for growing gilts.—Three gilts (seven-eighths Berkshire and one-eighth native) averaging 69 pounds in weight at the beginning of the test, made good gains from January 15 to May 1, when fed a grain mixture of equal parts by weight of copra meal (low in fat content), damaged rice (cooked), and cull dried Lima beans (cooked). The lot was kept in a portable colony pen where plenty of green feed was available at all times. Ordinarily it is not practical to feed Lima beans to swine, and doubtless other locally grown beans could be substituted for them in a similar mixture.

Copra meal and cassava for mature and for older growing stock.—Five mature grade gilts made good average gains during periods of 41 to 60 days (three of the lot were fed for 41 days and two for 60 days) on a ration consisting of copra meal (low in fat content) and fresh cassava. Two mature pure-blood boars and three young sows were also kept in good condition on this ration. Undoubtedly it would be too bulky for young pigs and probably would be considered so for mature stock, but the results accomplished are sufficiently promising to warrant further trial. The feeds are of particular local importance on account of their availability and low cost. The animals are likely to become too fat when they are fed a large amount of copra meal, especially local copra meal, which has a high fat content.

Comparison of native with improved feeding methods.—From weaning time (November 12) until the close of the year, three seven-eighths blood female pigs were kept at the station and three females of the same litter were kept by a native rancher. Those at the station were kept in a portable colony pen where they had access to an ample supply of green feed and were given plenty of concentrates. The pigs kept by the rancher were confined in a small pen and were

given no green feed and only a limited and poorly balanced ration. Near the close of the fiscal year (June 16) the gilts maintained by the station averaged 186.6 pounds in weight, while those kept by the rancher averaged only approximately one-fourth this weight.

FEEDING EXPERIMENTS WITH *LEUCÆNA GLAUCA*.

During the year tests were conducted to determine the effect on various classes of live stock of feeding leaves of the shrub *Leucæna glauca*, locally known as taṅgantaṅgan.

Young sprouts or twigs bearing new growth were fed to the station's mature Morgan stallion, which was given no other green feed during the time of the test. After a period of 12 days the hair of the mane and tail began to fall, and at the end of 16 or 18 days the animal had become rat-tailed and had lost all the hair of the mane. Apparently it did not relish the feed, as it ate only comparatively small amounts.

One native brood mare was fed new leaves of taṅgantaṅgan in combination with a limited amount of Para grass. (Pl. II, Fig. 1.) No change was noted until the end of 30 days, when the hairs of the tail and mane began to fall. Within the next 12 days the hairs of the tail and the greater part of the mane had disappeared. In another test, a native brood mare was tethered out by rope in a pasture where both taṅgantaṅgan shrubs and grass were growing. It was observed that the mare always preferred the grass to the shrubs. After two months' trial there was apparently no change in mane, tail, or body coat.

Two Ayrshire bulls, which were tethered out during the day, were fed young taṅgantaṅgan shoots at night, and two grade calves were kept in stalls and fed on this forage, being given no other green feed during the time of the test. None of these animals showed any change of coat after a period of 45 days. Cattle seem to eat taṅgantaṅgan much more readily than do horses.

Two grade kids, which were about 4 months of age at the time of the test, were kept in a dry lot and fed young growth taṅgantaṅgan, but showed no change in body covering at the end of 45 days.

In each of the above cases only young sprouts, or twigs bearing new growth leaves, of *Leucæna glauca*, were fed. Seed pods and flowers were not used in the tests.

A local rancher turned his native pigs onto a lot containing considerable taṅgantaṅgan, much of which had been cut a short time before. (Pl. II, Fig. 2.) The animals seemed to relish the tender leaves of the young sprouts, and 3 of the lot of 10 pigs tested had completely lost their body covering of hair after three or four months. The other animals appeared normal in this respect.

POULTRY.

The poultry project constitutes one of the most important lines of work of this station. Owing to the isolated position of the island and the quarantine regulations, which prohibit the entrance of live stock from near-by islands and from the Orient, fowls and fresh eggs must be produced locally for table use. These products

will likely continue to command good prices until the supply is greater than it is at present. It is thought that poultry raising should form a remunerative side line of the various farm activities and should be, as well, a means of furnishing food for the rancher and his family. At present the industry is confined chiefly to the raising of chickens, which are considered of much greater importance by the average Chamorro than are other classes of poultry. Some of the people do not care for ducks, and but few of them have success with turkeys.

It is thought that lack of knowledge concerning proper methods of feeding, care, and handling on the part of the native farmers is the cause of the present comparatively small production of poultry and poultry products. The station has amply demonstrated that such obstacles as parasitic and other diseases and insects and rodent pests can be successfully controlled, and it has shown that, through care, good feeding, and wise selection of the native stock, marked improvement in the egg production of the native hens may be accomplished without the introduction of pure-bred stock.

On account of the lack of suitable storage and feed-preparing facilities and the financial inability of the station to purchase other much-needed equipment, the work of the poultry division was confined to the breeding of pure-bred Rhode Island Reds and the development of a new variety from a cross of the native hens with the Rhode Island Red cocks. Some incidental data relative to breeding, incubation, and brooding are being accumulated.

SINGLE COMB RHODE ISLAND RED VARIETY.

At present the Single Comb Rhode Island Red is the only pure-bred variety of chickens kept by the station. The breeding of this variety is being conducted for the double purpose of establishing, through rigid selection, an improved station breeding flock and of producing pure-bred stock for distribution to the poultry raisers of the island. The work is making slow but steady progress. Individual and average egg production records of selected layers showed that the Guam-raised pullets made a slightly better showing than did the imported hens. The locally grown stock has also shown some improvement in type and plumage color. The results obtained so far are encouraging, and as more data are obtained on the individual merits of the breeders the work will be brought under better control than is the case at present.

RHODE ISLAND REDS CROSSED WITH NATIVE WHITE HENS.

The first cross in the variety development work mentioned in previous reports was made during the year. The native hens have been improved through rigorous selection through several generations and in many respects resemble the Single Comb White Leghorn variety, but are smaller in size and lay smaller white eggs than does the latter variety. They are good layers, considering the fact that they were selected from farm flocks, the best of which are poorly bred from the standpoint of modern methods of selection. The

average production of 10 of these hens for one year was 128.3 eggs, the highest individual record of the 10 being 149 and the lowest 112. This record is high compared with that of the average native hens and it exceeds that of many of the pure breeds raised in the Tropics.

These results indicate the possibility of improving the native stock through selection and careful handling and feeding. The characteristics of the native parents which it is desired to have transmitted to and retained by the hybrid offspring are mainly their hardiness and white color of eggshell. The characteristic to be improved upon in particular is size of both fowls and eggs. The Rhode Island Red seems to produce better offspring when crossed with the native hen than does either of two other pure breeds formerly tried by this station. It was for these reasons and in the hope of increasing the prolificacy of the native hen that the station undertook experiments in crossbreeding work. The establishment by the union of pure breeds and unimproved or native types of a new breed or variety, retaining one or more characters of the native type, presents many problems not met with in the case where a variety is evolved from a union of pure breeds only.

The progeny resulting from the first-cross matings are larger and produce larger eggs than the native parents. There is also a marked improvement in texture of eggshell. The predominating color of the plumage is red, while that of the eggs is variable, showing gradations from pure white to brown.

A sufficient number of selected hybrid pullets and cockerels were produced during the year for breeding work next season. Some very high layers are numbered among the young native hens which are to be kept to make up two additional breeding pens. They will be mated with two of the best Rhode Island Red cockerels for the production of more first-cross hybrids. Those produced during the past season are satisfactory, but it is hoped that as a result of better selected parentage the progeny of the two Rhode Island Reds crossed with the native hens will show even greater improvement than do the hybrids of the first cross.

PUBLIC IMPROVEMENT WORK.

In connection with the distribution of improved breeding stock, more than 100 settings of eggs from grade and pure-bred Rhode Island Reds were distributed to local poultry raisers, including members of the boys' and girls' poultry club. Although the majority of the club members are located in outlying districts, they keep in direct touch with the activities of the station through their district supervisors and the extension agent, and it is principally through them that information, relative to improved methods of raising stock, is disseminated. In addition to its regular distribution of eggs and surplus stock, the station received from the States on August 12, for disposal to the farmers of the island, 14 Rhode Island Red chickens, 2 Bronze turkey toms, and 6 Indian Runner ducks. The care and subsequent sale of the consignment was handled by the station and the purchase and shipment were made through the courtesy of a San Francisco firm.

REPORT OF THE ASSISTANT IN AGRONOMY AND HORTICULTURE.

By JOAQUIN GUERRERO.

AGRONOMY.

Following the return, in January 1921, of the agronomist-horticulturist to the States, the assistant assumed direct charge of the agronomic and horticultural work of the station. In addition to his other duties, he served as a member of the Agana fair committee, having direct charge of the agronomic and horticultural exhibits and acting as judge of the agricultural products at the fair.

FORAGE CROPS.

Considerable attention was again focused on the production of improved forage crops. The raising of live stock is one of the principal industries of the island, and the improvement of native pastures and the growing of suitable soiling crops are necessary for the development of this industry.

GRASSES.

The adaptability to Guam soils of the valuable introduced *Paspalum* as a pasture grass and of Para as a soiling crop has been demonstrated by the station. During the year trials were also made with other grasses, some of which, especially Napier or elephant grass, Japanese cane, and Guatemala grass, promise, under certain conditions, to be equal, if not superior, to Para grass for soiling purposes. The tests were conducted on two-hundredth acre plats. The results indicated the comparative value of these grasses.

Para grass (*Panicum barbinode*).—Para grass furnished the bulk of the roughage fed to the station live stock during the year. Trials extending over several years with this forage have shown its palatability and feeding value. Many of the station animals which were thin in flesh from running on native pastures gained rapidly in weight when put on Para pasture. In comparative palatability tests, cattle have closely pastured Para grass before feeding on *Paspalum* and native grasses growing in adjoining pastures, and they have fattened more rapidly on Para than on *Paspalum* grass. Para grass will not stand nearly the heavy grazing that *Paspalum* grass stands, however, and it is more easily killed out by weeds and other growth after close pasturing than is the latter. About 12 acres of lowland were prepared and planted to Para grass at the Cotot stock farm during the rainy season. This grass is gradually being established throughout the island.

Information is frequently requested regarding the advisability of planting Para grass among young coconut trees. A test carried on at Cotot showed that when the grass is not kept down the young trees become stunted in growth, and that when it is not allowed to encroach upon the root zone of the trees, the trees make a fairly good growth. Intercropping young orchards with Para grass is not to be generally recommended. Probably the planting of some cultivated crop between the young trees would be a good practice. In the older orchards a growth of Para would not only furnish feed for



FIG. 1.—IMPORTED AYRSHIRE BULL STEYBRAE LORD STERLING.



FIG. 2.—PORTABLE COLONY HOUSE AND RUN. HOUSE CONSTRUCTED FROM SCRAP LUMBER, AND RUN MADE OF 1 BY 6 INCH MATERIAL.



FIG. 1.—NATIVE PONY SHOWING EFFECTS OF BEING FED "TAÑGANTAÑGAN"
(LEUCAENA GLAUCA).

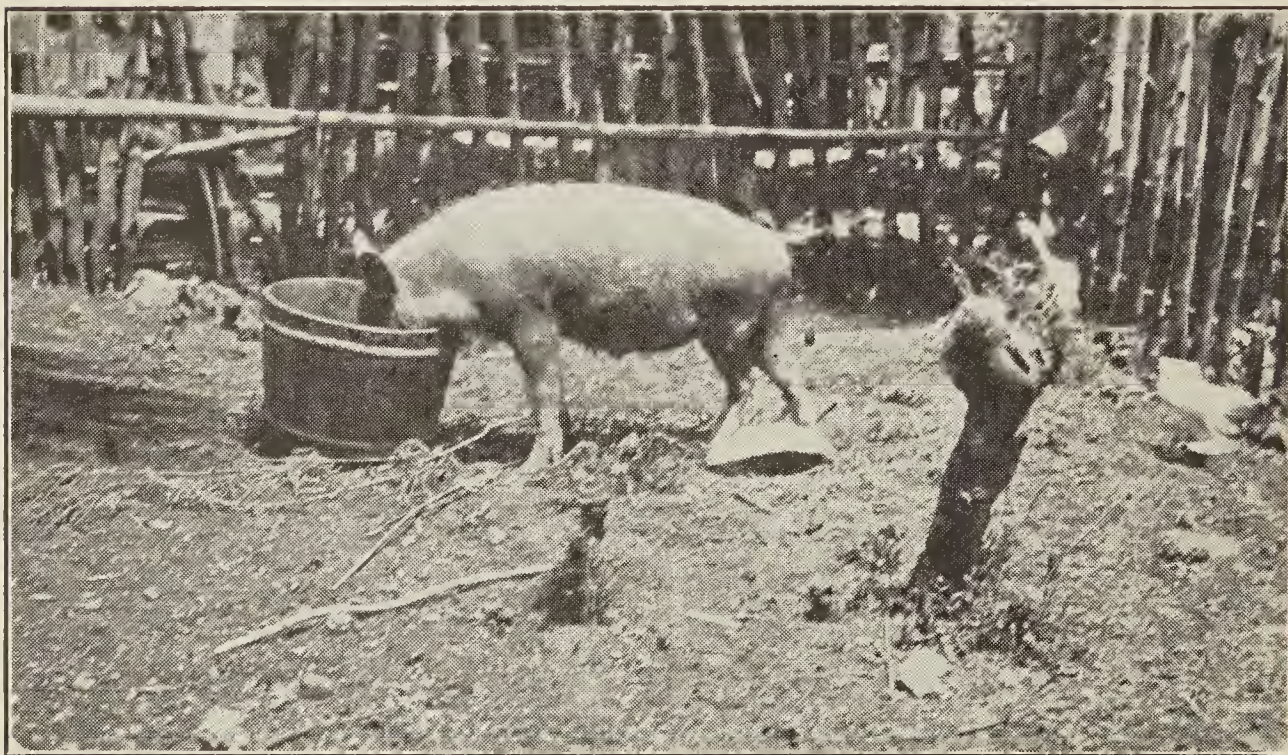


FIG. 2.—NATIVE PIG SHOWING EFFECTS OF BEING FED "TAÑGANTAÑGAN"
(LEUCAENA GLAUCA).

live stock, but it would doubtless be preferable to weeds, brush, and other volunteer growth which are allowed to spring up in many of the orchards.

Paspalum or *Australian water grass* (*Paspalum dilatatum*).—*Paspalum* continues to hold first place as a pasture grass for Guam. It is adapted to a wide range of soils, withstands extremes of drought and heavy rainfall and much heavier grazing than does Para grass. On June 18, 1920, a small trial plat was prepared and planted to *Paspalum* grass for the purpose of testing its possible comparative value as a soiling crop. On September 28, 1920, the grass began to flower, and on November 9, when it had attained a height of 27 inches, it was cut the first time. During the year two cuttings, yielding a total of 31.56 tons to the acre, were made. Comparatively small area was planted to *Paspalum* grass during the year, due to shortage of labor. At the Piti station the labor force was too small to permit of new plantings of this grass, and at Cotot only about 10 acres were prepared and planted. Pasture experiments carried on at Cotot showed that plantings started with root divisions stand more heavy and continuous pasturing, especially during the dry season, than do those propagated from stem cuttings. The former method entailed a little more labor than did the latter, but the benefit derived from it more than justified the extra expenditure.

Observations on the comparative efficiency of *Paspalum dilatatum* and native grass (*Andropogon acicu'atus*) in the lowland horse pastures showed that the native grass is not only more seriously affected by drought than is the introduced sort, but that it is also injured by continued and excessive rainfall, since it makes very little growth during either of these periods. The lowland native pasture, after being closely grazed during the rainy season, became severely infested with the two weeds, mumutong (*Cassia occidentalis*) and batunes (*Mesosphærum capitatum*). If allowed to get a good start, these weeds will often seriously impair or even kill a stand of grass. So far, they have not given serious trouble in the *Paspalum* pastures, but aroma (*Acacia farnesiana*) is a very troublesome pest not only in the lowland but also on some of the upland areas.

Guinea grass (*Panicum maximum*).—Within the last few years guinea grass has received very little attention in Guam. The survival of small areas in and about the station for some years without any care whatever would seem to indicate the adaptability of this grass to local conditions. On May 24, 1920, a small plat was prepared and planted with root divisions from the above-mentioned areas. Some of the plants started to blossom the following June, and on August 6, when the plants were about 80 inches high, they were cut for the first time. During the year five cuttings gave a total yield of 60 tons of green forage to the acre.

Sudan grass.—The stock readily eat Sudan grass, even after it has begun to seed. Cuttings were generally made, however, at the time the plants started to bloom. At the beginning of the year a small test was started for the purpose of comparing drilled with broadcasted methods of planting Sudan grass. Both plats were planted on August 6, 1920. The drilled plat flowered on October 4,

1920, when the plants were about 75 inches high, and the broadcasted plat blossomed two days later, when the plants measured 93.2 inches. Four cuttings were made in each plat, the first being on October 28, 1920. The drilled plat produced a total yield of 20.55 tons, while the broadcasted plat yielded 17.32 tons per acre.

Guatemala grass (*Tripsacum laxum*).—This grass is readily propagated either by root division or by stem cuttings. It is a coarse, heavy yielding perennial, having wide, heavy leaves which at a distance resemble corn blades. (Pl. III, Fig. 1.) The station stock seem to relish it, eating the whole plant even when the stalks are rather coarse. The grass was planted for the first time at the station May 20, 1920, and the first cuttings were made December 18, when the plants were about 101.8 inches high. Two cuttings yielding 150.42 tons per acre were obtained from this planting during the year. One of the plants, which was left to flower at the time the first cutting was made, blossomed on October 28, 1921. Another planting, made on November 24, 1920, was cut on June 29, 1921, when the plants were about 104 inches high. The plat suffered from the excessive rains of the two months following the time of planting and yielded only 36 tons per acre. Judging from the experimental work already done, it is thought that Guatemala grass planted on low soil, even when fairly well drained, will not do well during periods of heavy rainfall.

Japanese cane (*Saccharum officinarum*).—This cane is comparatively new as a forage in Guam and promises to make an excellent soiling crop. It is generally propagated by cuttings. When they were cut at the proper time both leaves and stems of plants were readily eaten by horses and cattle. The canes should be cut before they become too coarse or when between 60 and 72 inches high; otherwise they become hard and unpalatable. The first trial plat was made at the station on May 20, 1920, and on December 18, when the plants were about 90 inches high, the canes were cut. Two cuttings were obtained during the year, the total yield being 57.33 tons per acre. The second test was made on November 28, 1920, and the first cutting was made May 18, 1921, when the plants were about 121 inches high. The yield from this planting in a single cutting was 70.5 tons per acre. The station distributed propagating material to a few cattle raisers for trial.

Napier or elephant grass (*Pennisetum purpureum*).—This is a tall canelike, nonsaccharine perennial grass which reaches a height of from 15 to 18 feet when fully developed. (Pl. III, Fig. 2.) Analyses show that it is apparently more nutritious than corn fodder. It is greatly relished by both horses and cattle, and is one of the most promising of the various soiling crops tested by the station. In yield it excels Para grass. The grass is usually propagated by cuttings which take root readily when planted in a fairly moist soil. It may also be grown from seed, but this method seldom results in a good stand, as the seeds soon lose their viability. Root divisions may also be successfully used. The leaf is narrow, long, and slightly rough, being provided on the upper side with coarse prominent trichomes. Napier grass should be cut while it is still in a succulent stage because it soon loses its palatability and becomes coarse when allowed

to reach maximum development. From a planting made November 20, 1920, one cutting yielding 51 tons per acre was obtained on May 16, 1921, when the plants were about 134 inches high. The grass was allowed to make greater growth than is advisable when it is to be used for forage because the material was wanted for propagating purposes. The plants blossomed February 11, 1921.

Pennisetum setosum.—This is a perennial species allied to Napier grass, but is distinguished from the latter in that it is finer and shorter in stalk and has a tendency to flower more profusely. The leaves are shorter and narrower than those of *P. purpureum*, and they are slightly pubescent on both sides. It is propagated by means of root divisions, seeds, and cuttings. When wanted for green forage the plants should be cut at the first appearance of the seed spike. (Pl. III, Fig. 3.) The seeds, which mature very rapidly after the plant blossoms, are very light, and unless collected, will scatter and take root when moisture and other conditions are favorable. Compared with many of the other soiling grasses, *P. setosum* gives a low forage yield, but the crop seems to be fairly drought resistant. A planting made June 18, 1920, yielded four cuttings which gave a total yield of 51.04 tons per acre. The plants started to flower on October 11 when they were about 86 inches high, and were cut for the first time on November 9, 1920.

Ragi (Eleusine coracana).—Seed of this crop, received during the year from the Philippine Bureau of Agriculture, was sown in a small trial plat. The plants were between 25 and 30 inches high at maturity, but made a comparatively low yield of forage which did not seem to be relished by the stock. In a test begun March 7, 1921, the plants were observed to flower for the first time on May 23, and on June 29 they yielded 738 pounds of grain and 2 tons of forage per acre. In India, during times of scarcity, the grain of this crop is used as a substitute for rice.

Other forage crops recently introduced and tested by the station are teosinte and pearl millet, the seed of which was received from the Bureau of Plant Industry, United States Department of Agriculture.

SORGHUMS.

Sorghums are comparatively easy to grow in Guam. They are not very exacting as to their requirements, but do best on rich soils. The forage makes a good roughage for stock, and the grain an excellent feed for chickens. Damage done by caterpillars may be considerably reduced by planting the crop at the end of the rainy season so that the grains will mature and be ready for harvesting during the dry season. Different varieties of sorghum, erroneously known as "cebada," which is Spanish for barley, are well distributed throughout the island. In the variety test conducted at the station *feterita* gave the highest yield of green forage, and Black Amber cane produced the largest amount of grain.

The following table gives the results of the variety tests with sorghums:

Sorghum variety test.

Variety.	Date planted.	Date headed.	Height.	Date of first harvest.	First crop.		First ratoon crop. ¹	Total yield.	
					Grain.	Green forage.	Green forage.	Grain.	Green forage.
			Inches.		Pounds.	Tons.	Tons.	Pounds.	Tons.
Red Amber.....	1920. Dec. 15	1921. Feb. 7	80.6	1921. Mar. 22	2,700	7.95	7.75	2,700	15.70
Black Amber.....	1921. Jan. 6	Feb. 25	79.4	Apr. 26	3,225	8.55	18.10	3,225	26.65
Orange.....	Mar. 7	Apr. 18	87.2	June 7	1,687.5	17.00	8.50	1,687.5	25.50
Dwarf hegari.....	...do....	Apr. 17	61.6	...do....	400	18.50	7.50	400	26.00
Whitehull kafir.....	Jan. 6	Feb. 21	81.0	Apr. 26	1,837.5	6.00	15.30	1,837.5	21.30
Schrock.....	...do....	Feb. 24	83.6	...do....	2,412.5	7.75	15.30	2,412.5	23.05
Kafir.....	...do....	Mar. 4	66.8	...do....	2,362.5	5.20	9.50	2,362.5	14.70
Feterita.....	Mar. 7	Apr. 20	88.0	June 7	1,025	16.00	11.00	1,025	27.00
Blackhull kafir.....	...do....	...do....	113.6	...do....	4,200	17.00	8.00	4,200	25.00
Yellow milo.....	...do....	...do....	93.2	...do....	2,487.5	16.50	8.00	2,487.5	24.50
Dwarf Yellow milo ..	...do....	Apr. 21	75.8	...do....	2,175	14.00	11.00	2,175	25.00

¹ The heads of this crop being destroyed by caterpillars, no grain was obtained from it.

LEGUMES.

The efficiency of legumes as cover crops and as green manure has been demonstrated by the station. They are strongly recommended for use as an intercrop with grains and fruit orchards, including coconut plantations. The prevailing practice of planting mungo beans between the rows of corn at the last cultivation is good, but the plants should be turned under after the beans have been harvested, rather than removed from the soil as is generally the case.

Cover crops.—Of all the legumes grown at the station, velvet beans have been most satisfactory as a cover crop. At the Tarague coconut plantation, however, where extensive cooperative work with Patani beans, velvet beans, jack beans, and cowpeas were tested on a large scale for use as cover crops, the Patani beans were most efficient in keeping down weed growth in a given space, although the velvet beans spread over a greater area. The Patani beans also covered the ground efficiently for a greater length of time than did the other crops. The cowpeas made a fairly good cover crop but did not last long enough to be satisfactory. The jack beans did not keep down the weeds and undergrowth as effectively or cover the ground for as long a period as did either the velvet or Patani beans, and in a number of the areas they were attacked by a disease resembling mosaic. At the close of the year only the Patani beans showed vigorous growth.

Green manure.—The average Guam farmer can not afford to purchase commercial fertilizers, and the supply of barnyard manure is rather limited as the farm animals are seldom stall fed. For these reasons green manure crops are of special local value. Experiments carried on by the station have shown that the lowland soils are greatly benefited by the turning under of green leguminous crops.



FIG. 1.—GUATEMALA GRASS.



FIG. 2.—NAPIER GRASS.



FIG. 3.—PENNESETUM SETOSUM, SHOWING
NUMEROUS SEED SPIKES.

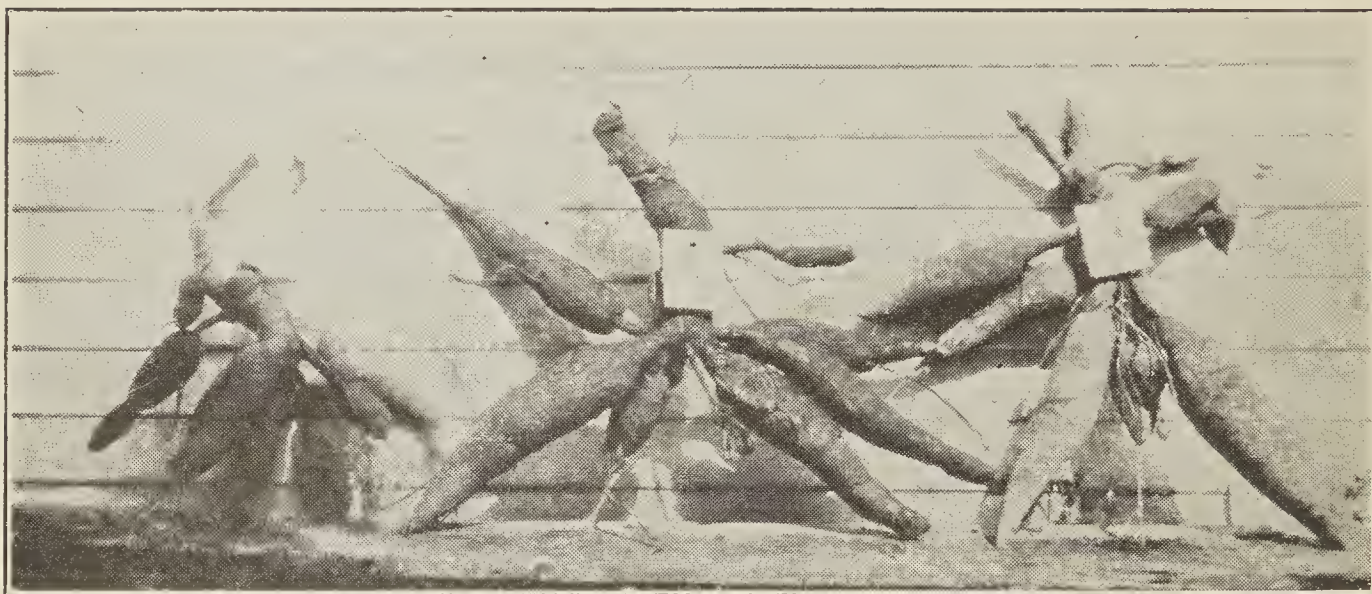


FIG. 1.—VARIETIES OF CASSAVA, SHOWING DIFFERENT ARRANGEMENTS OF ROOT DEVELOPMENT: (1) AMARILLO (YELLOW); (2) NATIVE; AND (3) APACA (WHITE).



FIG. 2.—MABOLO (*DIOSPYROS DISCOLOR*), SHOWING FRUIT AND ARRANGEMENT OF SEED.

These soils are heavy clay loams and at times are very difficult to work, cracking and becoming hard in the dry season, and running together and puddling during the rainy season. The turning under of successive crops of cowpeas at the Piti station has greatly improved the tilth of soil of this nature. Some of the progressive farmers are beginning to appreciate the advantage of growing green manure crops to increase crop yields. The station has distributed considerable seed during the year for this purpose.

Velvet beans (*Stizolobium* spp.).—Two variety tests each including 10 varieties of velvet beans were completed during the year. The Black Mauritius made the best cover crop, giving the heaviest growth and covering the ground for the longest period of time. The following table gives the results of the two tests:

Effect of time of planting on yield of different varieties of velvet beans.

Variety.	Date blos- somed.	Date first pods matured.	Date of first har- vest.	Length of vine.	Yield of seed per acre.
Planted May 22, 1920:	1920.		1920.	<i>Inches.</i>	<i>Pounds.</i>
100-Day Speckled.....	July 20	.....	Oct. 21	79.4	862.6
Alabama.....	do.....	.....	Sept. 28	86.4	875.2
Georgia.....	do.....	.....	Oct. 21	78.2	388.0
Lyon.....	July 26	.....	Oct. 28	82.8	1,262.6
Osceola.....	July 24	.....	Sept. 28	81.2	562.6
Yokohama.....	.....	.....	Oct. 28	76.6	1,425.0
Black Mauritius.....	Sept. 28	.....	Dec. 31	89.8	837.5
Bush ¹	Sept. 2	.....	Sept. 28	26.4	150.0
Chinese ²	Sept. 20	.....	Nov. 29	84.0	500.0
Florida ³	Sept. 7	.....	Nov. 20	.....	162.6
Planted Dec. 15, 1920:	1921.	1921.	1921.		
100-Day Speckled.....	Feb. 6	Mar. 20	Apr. 13	110.0	2,100.0
Alabama.....	do.....	Mar. 30	Apr. 7	110.8	2,812.5
Georgia.....	Feb. 5	Mar. 26	Apr. 13	106.2	2,625.0
Lyon.....	Feb. 9	Apr. 18	Apr. 22	130.6	3,075.0
Osceola.....	Feb. 15	do.....	Apr. 23	116.8	1,725.0
Yokohama.....	Feb. 11	Apr. 14	Apr. 22	124.0	3,500.0
Black Mauritius ⁴	Feb. 14	May 5	May 12	146.0	1,850.0
Bush ⁵	Jan. 28	Mar. 19	Mar. 28	41.0	.....
Chinese.....	Feb. 25	Apr. 25	May 10	132.0	4,012.5
Florida.....	Feb. 6	Mar. 26	Apr. 13	118.4	1,387.5

¹ Replanted June 5.
² Replanted June 18.
³ Planted June 5.

⁴ Still producing at the close of the year.
⁵ Very few plants came up.

Yokohama produced the highest yield of seed per acre, followed by Chinese, as a close second.

Cowpeas (*Vigna sinensis*).—Cowpeas, principally because of their value as a human food, are rapidly becoming an important leguminous crop in Guam. The crop was damaged to some extent throughout the islands by rats and grasshoppers. Rats especially seem very fond of the young pods.

In the two variety tests completed during the year, Iron gave the highest yield of peas per acre (1,268.85 pounds), followed by the Red variety with a yield of 1,081.25 pounds. Early Buff matured earliest and showed a tendency to grow upright rather than to spread. The results of the tests are summarized in the following table.

Effect of time of planting on yield of different varieties of cowpeas.

Variety.	Date blos- somed.	Date first pods matured.	Date of first harvest.	Length of vine.	Yield per acre of—	
					Seed.	Green forage.
Planted May 21, 1920:	1920.		1921.	Inches.	Pounds.	Tons.
Brabham.....	July 2	.....	Aug. 3	60.8	237.6	.....
Early Buff.....	June 25	.....	July 23	.....	1,100.0	4.45
Red.....	July 7	.....	July 27	.....	600.0	5.10
New Era.....	June 30	.....	July 23	80.4	837.0	.....
Victor.....	Aug. 4	.....	Oct. 20	62.0	62.6	.....
Groit.....	July 1	.....	Aug. 3	62.0	1,162.6	.....
Whippoorwill.....	July 7	.....	do.....	65.2	350.2	2.90
Iron.....	July 2	.....	July 23	72.8	800.2	2.60
Planted Dec. 15, 1920:	1921.	1921.				
Brabham.....	Jan. 28	Feb. 14	Feb. 23	121.4	1,162.5	6.20
Red.....	do.....	Feb. 12	Apr. 22	90.2	1,562.5	8.10
New Era.....	Jan. 17	Feb. 3	do.....	113.8	1,175.0	7.80
Victor.....	Jan. 30	Feb. 5	May 4	113.4	625.0	8.00
Groit.....	Jan. 17	Feb. 4	Apr. 22	96.0	700.0	9.80
Iron.....	Jan. 25	do.....	do.....	104.8	1,737.5	6.90

Pigeon peas (Cajanus indicus).—The pigeon pea was introduced very early in the history of the island by French sailors, whence the local name of French lentil. The peas are seldom given a field planting as are other crops and the plants growing on the island are found around ranch buildings or growing in a wild state. The dry peas make good feed for chickens and the forage yields an excellent stock feed.

In tests at the station the native variety yielded the largest quantity of seed and the British West Indies variety produced the largest quantity of forage per acre. New Era, a red-seeded variety which was selected for grain yield, ranks above the lowest in the production of seed. All the varieties were left to produce a ratoon crop. The following table gives the result of the tests:

Pigeon pea variety tests.

Variety.	Date blos- somed.	Date first pods ripened.	Height.	Date of first harvest.	Yield per acre.	
					Seed.	Green forage.
Planted May 22, 1920, in field A:			Inches.		Pounds.	Tons.
St. Vincent.....	Dec. 23, 1920	Jan. 26, 1921	109	Feb. 28, 1921	6,112.5	22.8
Dark Red (station se- lection).....	Nov. 15, 1920	Dec. 20, 1920	96	Dec. 24, 1920	4,975.0	11.0
New Era.....	Dec. 17, 1920	Jan. 25, 1921	162	Feb. 28, 1921	4,512.5	28.0
Columbia.....	Jan. 6, 1921	Feb. 7, 1921	170	Feb. 23, 1921	3,712.5	37.0
British West Indies....	Dec. 20, 1920	Feb. 4, 1921	123	Feb. 28, 1921	7,500.0	54.0
Native.....	Nov. 12, 1920	Dec. 20, 1920	102	Dec. 24, 1920	8,687.5	33.0

Patani beans (Phaseolus lunatus, mixed).—In an extensive co-operative experiment conducted on a coconut plantation to determine the value of Patani and velvet beans, cowpeas, and jack beans as cover crops, the Patani beans made the best cover crop, closely followed by velvet beans.

Mungo and other small beans.—Mungo beans are highly prized as a food by the Chamorro people and furnish a much-needed protein

supplement to the carbonaceous food crops commonly grown on the island. Considerable quantities of these beans are imported annually notwithstanding the fact that they can be easily produced locally. They occupied the land for a short period and made only a fair cover crop. The beans should be picked as soon as mature, otherwise the pods shatter freely, especially during the dry season. During the year two variety tests with mungo beans were completed. Upon averaging the results of the tests the black mungo was found to yield the highest and adzuki red the lowest quantity of seed. The results of the two tests are summarized in the following table:

Mungo and other small bean variety test.

Variety.	Date blos- somed.	Date of ripening of first pods.	Length of vine.	Date of first harvest.	Yield of seed per acre.
Planted May 22, 1920:	1920.		<i>Inches.</i>	1920.	<i>Pounds.</i>
Native mungo.....	July 5	.....	51.4	July 26	1,200.0
Hawaiian mungo.....	do	.....	54.0	do	900.0
Green mungo.....	June 23	.....	.....	July 19	1,400.0
Black mungo.....	July 7	.....	63.8	Aug. 23	2,150.0
Urd.....	July 16	.....	75.4	Sept. 10	1,825.0
<i>Phaseolus calcaratus</i> ¹	Aug. 4	.....	39.2	Sept. 15	1,762.5
Rice bean ¹	June 22	.....	52.8	July 23	1,937.5
Adzuki (buff).....	do	.....	.....	July 19	1,975.0
Adzuki (red).....	do	.....	.....	Aug. 3	937.6
Planted Nov. 27, 1920:	1921.	1921.		1921.	
Hawaiian mungo.....	Jan. 7	Jan. 24	26.4	Feb. 7	1,875.0
Green mungo.....	Jan. 6	do	26.6	do	1,487.5
Black mungo.....	Jan. 8	Feb. 5	37.4	Feb. 17	2,700.0
Urd.....	do	do	38.0	Feb. 15	1,225.0
<i>Phaseolus calcaratus</i>	Jan. 11	Jan. 28	39.4	do	1,525.0
Rice bean.....	Jan. 6	Feb. 4	23.6	Feb. 18	825.0
Adzuki (buff).....	Jan. 7	Jan. 19	13.6	Feb. 7	975.0
Adzuki (red).....	do	Jan. 26	13.4	Feb. 18	200.0

¹ Two varieties of rice bean.

In the second test the crop was planted in time to mature during the dry season and most of the varieties yielded considerably more grain than they did in the first test in which the crop matured in the rainy season. As the measurements indicated, however, the plants growing during the rainy season were larger and more vigorous than were those maturing in the dry season, and as a consequence they would have yielded a larger quantity of green forage.

Native varieties of beans.—The varieties White Cerebilla, Red Cerebilla, Judias, Chochomeco, Seguidillas, and Acangcang-tase were grown at the station during the year. Acangcang-tase (*Canavali obtusifolium*) was the most effective cover crop tested. This bean is found growing wild along the seacoast and bears rounded pods which are about 4 to 5 inches long and somewhat resemble those of the Chinese variety of velvet bean.

Soy beans (*Glycine soja* or *Soja max*).—In former years many attempts were made to grow soy beans, but no degree of success was attained until the past year. Two variety tests were made. The results of the first test were fairly satisfactory but a very poor stand was obtained in the second test, due apparently to the poor viability of seed, since weather and other conditions were favorable for growth. The results of the first test are summarized as follows:

Soy bean variety test.

Variety.	Date blossomed.	Height of plants.	Date of first harvest.	Yield of seed per acre.
Planted May 22, 1920: ¹	1920.	Inches.	1920.	Pounds.
Mammoth Yellow.....	July 7	22.2	Sept. 7	500.0
Laredo.....	do	31.8	Sept. 15	2,150.0
Hahto.....	do	19.0	do	1,037.5
Tokio.....	do	16.2	Sept. 28	175.0
Haberlandt.....	July 6	17.2	Sept. 15	162.6
Virginia.....	do	42.4	do	400.0
Biloxi.....	June 29	55.2	Sept. 7	3,600.0
Barchett.....	July 12	40.0	Sept. 28	1,625.0

¹ On June 5, 1920, all varieties were replanted with the exception of Biloxi.

Peanut (Arachis hypogæa).—Peanuts are not widely grown in Guam. A large part of the lowland of the island is heavy clay and therefore not well suited to this crop. In districts where the soil is suitable, the farmer could probably well afford to devote a small area to peanut cultivation for pasture crop for swine and for the production of nuts for the market. Three varieties of peanuts which have been grown for some time at the station were included in a test conducted during the year on two-hundredth acre plats. The soil on which these plantings were made is a heavy clay which gave comparatively low yields and made harvesting difficult. In many instances the pods were deeply embedded in hard masses of ground. The following table gives the results of the test:

Peanut variety test.

Variety.	Date harvested.	Yield per acre.	
		Seed.	Green forage.
Planted June 5, 1920:		Pounds.	Tons.
Large Chinese.....	Nov. 21, 1920	4,600	3.50
Guam-grown.....	Nov. 22, 1920	7,000	4.10
Small Chinese.....	do	1,500	2.35

In the second test a comparison was made between sexual and vegetative methods of propagation. No apparent differences were observed in the manner of growth of vine produced from seed and those grown from cuttings. The results of the test follow:

Peanut variety test.

Variety.	Date harvested.	Rate of yield per acre—			
		From cuttings.		From seed.	
		Seed.	Green forage.	Seed.	Green forage.
Planted Dec. 23, 1920:		Pounds.	Tons.	Pounds.	Tons.
Large Chinese.....	May 27, 1921	1,370	1.66	2,750	6.20
Guam-grown.....	do	9,150	7.50	1,834	4.75
Small Chinese.....	do	1,600	2.40	1,786	3.64

Kudzu bean (Pueraria thunbergiana).—A small trial packet of seed of this plant was received from the Bureau of Plant Industry, United States Department of Agriculture, and planted at the station

on August 6, 1920. None of the vines flowered, but they produced a thick, heavy mat of vine which covered the ground. At the end of the year some of the vines measured over 25 feet and produced a good supply of propagating material.

Bur clover (*Medicago hispida*).—Several unsuccessful attempts have been made at the station to grow clover. A small quantity of seed was produced in one test, but the plants grown from it died either soon after coming up or about the time the fourth leaves appeared. A good stand was obtained from unhulled bur clover seed received from California and from hulled seed from the Bureau of Plant Industry, United States Department of Agriculture. Nearly all the plants were killed by heavy rains, however, when they were beginning to bear a few mature pods.

ROOT CROPS.

Root crops constitute one of the stable foods of the Tropics. They are easily produced and are especially valuable in Guam after the occurrence of a destructive typhoon when other food crops are not available. During the year experiments were continued with taro, cassava, sweet potatoes, arrowroot, and edible canna.

Taro (*Colocasia esculenta*).—Taro is grown throughout the island and forms one of the principal starchy foods of the Chamorro. Not only is the root used as a food but the young tops make excellent greens. A test, in which the varieties Jalum-tano, Manila, Apaca, Visaya, Agrigan, Pacencia, and the so-called American taro were planted on both lowland and upland, showed that constant flooding in quantity sufficient to submerge about one-quarter of the entire plant was not conducive to good growth in the lowland plats, the best results being obtained when just enough water was used to keep the soil moist. Seven varieties were planted in the lowland, and those which were flooded continuously were failures. On plats receiving only sufficient water to keep the soil well moistened, Visaya gave the best results, yielding at the rate of 3,861.25 pounds per acre. No definite results were obtained from the upland variety test. The varieties differed much in their manner of growth and reproduction. Jalum-tano produced more suckers than did any of the other varieties, but was slow in making root growth. The so-called American variety, which has been grown on the island for some years and is as yet unidentified, produced a very large root surrounded with many elongated cormels, but no suckers or offshoots. It is probably a variety of yautia. The Manila variety had no central root of any size, but produced underground roots that formed suckers or offshoots at a little distance from the mother plant. The Apaca variety behaved like the Manila. The Visaya taro produced many suckers which sprang up some distance from the mother plant. The Agrigan produced roots like those of the dasheen, the central rootstock being almost round, of fair size, and surrounded by a number of good-sized round cormels, each of which sent up leaf-stalks close to the parent plant. Pacencia produced very few suckers.

Cassava (*Manihot utilissima*).—Cassava furnishes the bulk of starch produced on the island. This is due to its high yield and the ease with which it may be grown. The varieties Amarillo (yellow), Apaca (white), and the native mendioka were under investigation. Of these, Apaca contained more starch than did the other two

varieties, and Amarillo yielded the least. The roots of Amarillo are seemingly more subject to decay, especially during the rainy season, than are those of either of the other two varieties, and unless they are harvested as soon as the crop matures the yield will be considerably reduced by rot. (Pl. IV, Fig. 1.) Amarillo, which had been left in the ground too long and suffered loss from decay, yielded 1,361.25 pounds per acre in one test and 8,848.12 pounds in another test; Apaca yielded 19,057.5 pounds per acre in one test and 50,366.24 pounds in another; and the native variety yielded 27,225 pounds per acre in one test and 36,622.87 pounds in another. The yellow and white varieties were planted October 24, 1919, and the native variety November 26, 1919. All three varieties were harvested December 31, 1920.

Arrowroot (Maranta arundinacea).—The root of this plant furnishes an excellent quality of starch and is very white and firm. In a test started January 7, 1920, 6,300 pounds of fresh, clean roots per acre were harvested December 31, 1920.

Edible canna (Canna edulis).—This comparatively new starch plant was introduced into Guam from the Hawaii Agricultural Experiment Station. It resembles the wild cannas of Guam, the only difference being that the latter do not produce enlarged roots. A small trial plat was planted to edible canna at the close of the year and some planting stock was distributed to farmers.

Sweet potatoes (Ipomæa batatas).—The roots of this crop are subject to damage by sweet-potato weevils, which are very prevalent in Guam. To reduce the amount of damage the crop should be harvested as soon as it is mature, especially during the dry season when the weevils are present in great numbers. During the year, six varieties were tested on a small scale at this station, being planted October 7, 1920, and harvested February 25, 1921. The yields were as follows: Imported (American), 8,066 pounds; Patas-ngaŋga, 1,055.94 pounds; Dago, 810.69 pounds; Amarillo, 606.31 pounds; Yap, 524.56 pounds; Peru, 408.75 pounds per acre. Adverse weather and soil conditions at the time when the roots were about half-grown accounted largely for the low yields in all varieties. Drought caused the heavy clay soil to crack, breaking some of the lateral roots and weakening the vines to a great extent.

Rape (Brassica napus).—On July 25, 1921, a small plat was planted to Dwarf Essex or English rape. The plants made very satisfactory growth. It would seem that rape might well be grown locally, especially as a pasture crop for swine and as a green feed for chickens.

COTTON (GOSSYPIMUM SP.).

The varieties of cotton grown by the station for some years have given good results. The farmers of the island, however, take very little interest in cotton raising, probably because of the lack of a local market and the scarcity of farm labor. Nine varieties of cotton were planted by the station in small test plats during the year. Four pickings were made from all the plats before the plants were topped off for a ratoon crop, the first picking being done on May 17, 1921. Express yielded the highest amount of seed cotton per acre and Columbia produced the lowest of all. The following table gives the results of the tests.

Variety test with cotton.

Variety.	Date first squares formed.	Date first squares bloomed.	Date of first ripe pods.	Date of first harvest.	Height of plant.	Rate of yield per acre.
Planted Jan. 6, 1921:	1921.	1921.	1921.	1921.	<i>Inches.</i>	<i>Pounds.</i>
Trice.....	Feb. 21	Mar. 9	Apr. 26	May 17	57.4	675.00
Express.....	do.....	Mar. 8	Apr. 27	do.....	59.6	1,437.50
Wanamaker.....	do.....	Mar. 9	Apr. 26	do.....	56.4	950.00
Foster.....	do.....	Mar. 8	May 1	do.....	56.6	618.75
Mebane Triumph.....	Feb. 14	Mar. 14	May 5	do.....	50.6	581.25
Cleveland.....	Feb. 19	Mar. 8	Apr. 22	do.....	59.8	1,337.50
Lone Star.....	do.....	Mar. 7	Apr. 30	do.....	59.2	900.00
Columbia.....	Feb. 25	Mar. 8	do.....	do.....	58.8	465.25
Cook.....	Feb. 19	Mar. 5	Apr. 21	do.....	53.2	550.00

CORN (ZEA MAYS).

A variety test was started August 5, 1920, on well-drained land with three Guam-grown varieties and four obtained from the Virgin Islands. All the varieties were dwarfed and suffered much from insect attack, particularly from the European corn borer, and many of the leaves were striped green and white. The plants were sprayed with lead arsenate in combination with a nicotine sulphate preparation, and a few ears were saved and sufficient corn was obtained from each plat to repeat the test. Another planting of all varieties was made on November 27, 1920, but was destroyed by heavy rains.

RICE (ORYZA SATIVA).

Due principally to unfavorable weather and to the ravages of the rice bug (*Leptocorisa varicornis*), stem borer (probably *Nonagria inferens*), and leaf-folder (probably a pyralid), the rice crop was not as good as that of last year. Considerable damage was done, especially to the late maturing variety. The station recommends early planting, quick-maturing varieties, clean cultivation of the area surrounding the paddies, and smoking the plants occasionally from the windward side of the field at the time the rice plants are heading out, as means of combating insect pests. Fairly good yields have been obtained where these methods were carried out.

Variety tests.—Two varieties, the Guam (native) rice and the station-selected early maturing rice, were planted for comparison. The Guam rice, after starting to head, commenced to lodge. Only a few plants of the station-selected variety lodged, and the stand was even. The Guam rice matured in 130 days and the selected rice in 103 days. Insect infestations in both varieties were serious. In some of the plats most of the heads failed and the resultant yield was low. The following table gives the results of the variety test:

Rice variety test.

Variety.	Date soaked in water.	Date planted in nursery.	Date trans-planted.	Date harvested.	Average yield per acre—		
					Cleaned paddy.	Straw.	Total.
	1920.	1920.	1920.	1921.	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Guam (native).....	Sept. 1	Sept. 4	Oct. 12	Feb. 22	270.0	3,040	3,310
Selected (G. E. S.).....	do.....	do.....	do.....	Jan. 25	288.4	3,063	3,351.4

Fertilizer tests.—Iloilo variety and Guam rice were each planted on 12 tests plats. The same amounts and kinds of fertilizers were applied as in previous tests, with the exception of potassium, which was not available. The Guam rice was considerably taller and the stand was much more uniform than the Iloilo rice, but it made a low yield, very few of the heads filling and the plants lodging severely. In an effort to save as many as possible of those plants which had lodged it was deemed advisable to turn off the water supply, but this proved of little effect. The results indicated that the Iloilo rice is more promising than the Guam. Plat No. 7, to which ammonium sulphate and acid phosphate were applied, produced the highest yield of clean, unhulled paddy, followed by plat No. 4, to which acid phosphate alone was applied. With the exception of the plats from which no results were obtained, plat No. 11, to which lime alone was applied, produced the lowest yield of all those in the test. The following table summarizes the results of the rice fertilizer test:

Effect of fertilizer on yield of rice.¹

Number of plat.	Treatment per acre. ²	Yield per plat.				Average yield per acre.		
		Clean paddy.		Straw.		Paddy.	Straw.	Total.
		Iloilo.	Guam.	Iloilo.	Guam.			
		<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
1	Check (no treatment)...	56.0	8	304	184	640	4,240	4,880
2	Sodium nitrate, 266 pounds.....	31	.....	215	.....	620	3,680	4,300
3	Ammonium sulphate, 200 pounds.....	26	.....	53	.....	520	540	1,060
4	Acid phosphate, 166.5 pounds.....	66	17	424	183	830	5,240	6,070
5	Potassium sulphate, 95 pounds.....	31	.....	281	.....	620	5,000	5,620
6	Sodium nitrate, 266 pounds, or ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds; and potassium sulphate, 95 pounds.....	.....	.....	.....	.....	.....	.....	.....
7	Ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds; and potassium sulphate, 95 pounds.....	58.5	.....	.....	369	1,170	6,210	7,380
8	Ammonium sulphate, 200 pounds; and potassium sulphate, 95 pounds.....	37.5	.....	369	.....	750	6,630	7,380
9	Acid phosphate, 166.5 pounds; and potassium sulphate, 95 pounds.....	.....	.....	.....	.....	.....	.....	.....
10	Ammonium sulphate, 200 pounds; and acid phosphate, 166.5 pounds.....	27	.....	435	.....	540	8,160	8,700
11	Lime, 1,000 pounds.....	7	.....	220	.....	140	4,260	4,400
12	Ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds; and potassium sulphate, 95 pounds; and lime, 1,000 pounds.....	.....	.....	.....	.....	.....	.....	.....

¹ Rice planted in nursery September 4, 1920, transplanted to field October 12, 1920, and harvested between January 24 and February 22, 1921.

² No potassium sulphate has been applied since the fiscal year 1919.

Upland rice variety tests.—In this test were included Mangasa, Inantipolo, Apostol, Guam, Selected (G. E. S.), and Iloilo. Seed of

the three former varieties was obtained from the Philippine Bureau of Agriculture, and the three latter varieties have been grown at the station for some time. Each of the varieties was planted in drills or rows on two plats, the drills in one plat being 1 foot apart and in the other 2 feet apart. In the course of the experiment practically all the varieties at the time of heading were severely damaged by the salt air which was carried in by continuous high winds from the northeast. There was no lodging. The Guam rice was the only one of the six varieties which failed to produce grain, but the others yielded scarcely enough seed for continuation of the work. The Mangasa variety produced the largest amount of clean paddy per acre, and the plat in which the rows were made 1 foot apart produced on the average more paddy than did the plat in which the rows were set 2 feet apart.

TOBACCO (*NICOTIANA TABACUM*).

Eight varieties of tobacco were tested. All gave good results. Connecticut Broadleaf gave the largest yield, followed by the native variety. Yellow Pryor produced the lowest yield. The average weight of leaf of Connecticut Broadleaf was found to be 0.843 ounce, which is the heaviest of all the varieties. Saipan came second, with a weight of 0.839 ounce.

In order to control insect infestation, the station resorted to handworming and to spraying with lead arsenate in combination with a nicotine sulphate preparation. Handworming was more effective than spraying for the control of worms during the rainy season. This method is very slow and tedious, however, and it is practical only where labor is cheap and production is on a very small scale.

Tobacco seedlings were found to be very susceptible to damping-off in the seed bed, and a small test was conducted in the plant house in the hope of finding a means of checking this fungous disease. The eight varieties were sown in two separate lots, the soil in one lot being sterilized with steam and in the other lot being left untreated. The plants in the treated lot made vigorous growth and were practically free from damping-off, while the seedlings in the check lot suffered greatly from the disease and were not as healthy as the plants in the treated lot. It was noted that the sterilized soil did not hold moisture as well as did the unsterilized.

The results of the tobacco variety test are given in the following table:

Tobacco variety test.

Variety.	Date sown in flats.	Date of germination.	Date of blossoming.	Height.	Date first primed.	Yield per acre.	
						Number of leaves.	Weight.
Planted Aug. 31, 1920:	1920.	1920.	1920.	<i>Inches.</i>	1920.		<i>Pounds.</i>
Saipan.....	June 21	June 29	Nov. 16	44.4	Dec. 17	54,800	2,875
Miscellaneous.....	do.	do.	Nov. 25	33.0	do.	73,400	3,825
Yellow Pryor.....	do.	do.	do.	35.4	do.	50,000	900
Orinoco.....	do.	do.	Dec. 5	36.4	do.	38,000	1,300
Maryland Broadleaf.....	do.	do.	Nov. 29	31.8	do.	53,000	1,400
Guam native.....	do.	do.	do.	40.4	do.	117,800	3,825
Zimmer Spanish.....	do.	do.	Dec. 5	44.0	do.	190,600	3,762.5
Connecticut Broadleaf.....	do.	do.	Dec. 10	44.4	do.	145,400	7,662.5

SUGAR CANE (*SACCHARUM OFFICINARUM*).

Much of the lowland soil of the island seems to be well adapted to sugar-cane growing, yet cane is grown only on a very small scale at present. The Chamorro farmer prefers the Rayao and Neti varieties. The station undertook some investigational work with sugar cane during the year, local interest in the crop having increased, and at the close of the year had a number of varieties under trial. Cuttings of the varieties Yontanzan, Cayana-10, and Uba were obtained from the Bureau of Plant Industry, United States Department of Agriculture, and after they had been sprouted in the nursery for about a month were planted in small test plats on June 30, 1921. The native varieties tested were Neti, Rayao, Agaga, and Gaimut.

SOILS.

The soils of Guam and particularly those at the station present unique and difficult problems. Some show very little mechanical and chemical difference but vary greatly in productiveness. The latter is most marked between newly broken grassland and old soil or soil that has been under cultivation for some time. On this account two samples of soil were submitted to the Bureau of Soils, United States Department of Agriculture, for analysis. Sample No. 4 was taken from grassland which had been under cultivation for about one year, during which time it had produced only dwarf plants. Sample No. 5 was taken from old, productive soil that had been under cultivation for at least 10 years. The following data are taken from the report of the Bureau of Soils on these samples:

Both samples were examined for unusual constituents only. The organic constituents except total organic matter could not be determined on so small a sample. The samples were examined for manganese, total organic matter, iron, hydrogen-ion exponent, etc., with the following results:

	Sample No. 4. <i>Per cent.</i>	Sample No. 5. <i>Per cent.</i>
Manganese-----	0.32	0.25
Nitrogen-----	.28	.23
Iron (ferrous)-----	.36	.08
Total organic matter-----	2.86	1.95
Total carbon-----	1.77	1.13
Total carbon dioxid-----	6.50	4.40
Carbon dioxid-----	Trace.	.27
Hydrogen-ion exponent-----	pH 6.4	pH 7.7

You will note that the older and better soil contains somewhat less manganese, very much less iron in the ferrous state, and some carbon dioxid as carbonate, and accordingly the hydrogen-ion exponent is higher. * * * The exponent 7 represents neutrality approximately, and the figures therefore indicate that the older soil is slightly alkaline, whereas the new and unproductive soil is acid. The main significance, however, lies in the higher ferrous iron content and the higher organic matter. The presence of this ferrous iron indicates that the soil is not well oxidized or aerated, and in addition to the poisonous properties of ferrous iron itself this condition of low oxidation or aeration would tend toward the existence of their unfavorable compounds.

Inasmuch as the analysis showed the new unproductive soil to be slightly acid, it was decided in November, 1920, to conduct a pot experiment to determine the effect of lime, applied in varying amounts, on both new and old soil. Applications were made at the rate of 1, 2, 4, 8, and 16 tons per acre. Three of the tests were com-

pleted during the year, the first of which was begun on November 13, 1920, the second on January 25, 1921, and the third on April 19, 1921. At the end of the first test the plants in the pots which had received lime at the rate of 16 tons per acre, especially those in new soil, had made very poor growth. In the second and third tests, however, the plants growing in the new soil, which had received lime at the rate of 16 tons per acre, made slightly better growth and larger yields than did those in the old soil which received the same application.

Rotation for soil improvement.—During the year the station formulated plans for a corn and legume rotation experiment. Seven plats are under experiment as a result, three for continuous culture and four for rotation. Corn, cowpeas, and velvet beans are to be used in the test. Two crops will be grown every year, one corn plat being rotated with cowpeas and the other with velvet beans. The experiment is arranged so that one plat will grow corn during the rainy season and be followed with cowpeas in the dry season. The continuous culture experiment will serve as a check on the rotation experiment. Only one harvest in this experiment was completed during the year, and the results of the test were far from satisfactory, as the crops suffered severely from attack by rodents and grasshoppers. The cowpeas were the most severely damaged of all the crops, the young pods being eaten by rats almost as soon as they appeared and the foliage damaged by young grasshoppers (probably katydids). Some damage was also done to the corn by the European cornstalk borer. The velvet beans apparently suffered no injury from these pests. Rodents were destructive from the time the seeds were planted until harvest time. In some cases they even nipped the tops of young corn plants. Steps are being taken to poison the rodents and insects.

HORTICULTURE.

During the year a bulletin on vegetable growing¹ was prepared by the horticulturist. This bulletin includes data accumulated by the station during a period of 10 years. It should be of great assistance to local gardeners and also to those in other tropical countries where conditions are similar to those obtaining in Guam.

TROPICAL-FRUIT INVESTIGATIONS.

Tropical-fruit investigations were confined principally to the keeping of the station trees and plants in as good condition as possible, with the limited amount of labor available, and to the propagation of nursery stock for distribution. The demand for fruit trees was comparatively heavy. A large number of papaya, avocado, mango, orange, and lemon trees were distributed, as were also chico (*Achras sapota*) and lanzon (*Lansium domesticum*) nursery stock, the seed of both of which was obtained from the Philippine Bureau of Agriculture.

Citrus.—Work with tropical fruits, especially with citrus, was unsatisfactory, due principally to the unsuitability of the station soil for this class of trees.

¹ Guam Sta. Bul. 2, Vegetable Growing in Guam.

Of the various cover crops grown in the citrus orchard, the velvet bean has given the best results. This crop, when growing in young orchards, should not be allowed to climb over the trees.

Strawberry.—A light yield of fruit of good quality was obtained. Considerable propagating material was distributed to various localities for trial. At the time the plants at the station began to send out runners they were attacked by what appeared to be a leaf blight or other fungous disease. The old planting was removed on this account and only strong and healthy runners were selected to start a new planting.

Pineapples.—In the pineapple variety and fertility test, the fourth crop was harvested near the close of the year, which completed the experiment. Data obtained on this crop show that the row which was treated with ammonium sulphate produced the highest total yield of pines per acre for both the Smooth Cayenne and Thorny varieties. Of the two varieties, that of the Smooth Cayenne gave much the higher yield. The test was conducted on a small scale, the total plat comprising about one-sixteenth acre. As soon as funds are available it is intended to repeat the test on a larger scale.

In the experiment carried on to compare suckers with crowns for planting, it was noted that the plat planted to suckers produced the first mature fruit in 162 days, while the plat planted to crowns required 383 days to mature fruit. Complete results have not as yet been obtained from this test.

Fruiting trees.—Trees producing fruit during the year included the santol (*Sandoricum koetjape*), rose apple (*Eugenia jambos*), manzanita (*Zizyphus jujuba*), Aberia (*Aberia gardinerii*), and mabolo (*Diospyros discolor*). Santol yields a fruit the acid pulp of which is edible. Rose apple produces a fruit which is ovoid and fleshy, and varying from pink to light yellow in color. Manzanita has a fruit which is fleshy and edible. Aberia continues to produce a good crop of fruit. The Chamorro children are especially fond of the raw, ripe fruit, and it makes good jellies and jams. Mabolo (Pl. IV, Fig. 2) yields a large, edible fruit, which is globular in shape, and very light cream or tan in color, with generally a reddish brown surface shade or blush on one side. The fruit is covered with a soft dense downiness or pubescence. The flesh has a fine texture, a mild flavor, and a peculiar and decided odor. It is relished by many but its odor is offensive to others. The heartwood of the mabolo tree yields a high-grade lumber which is sometimes used as a substitute for ebony.

GARDEN-VEGETABLE DEMONSTRATION.

During the year the demand for garden-vegetable seeds and plants was much greater than the station was able to supply. The boys' and girls' clubs have been largely instrumental in stimulating a lively interest in gardening throughout the island, and practically every district now has well-kept gardens that are maintained by the junior club.

Experiments on time of planting, and cultural methods and insect and disease studies were continued. Major efforts, however, were concentrated on tomato and lettuce improvement. The work on the whole was not as satisfactory as in other years owing to adverse weather conditions and to plant diseases.

Lettuce.—The best quality of lettuce in Guam is grown during the hot, so-called dry season, at which time it is often necessary to practice irrigation and advisable to provide the crop with partial shade. During the period of heavy rains the plat should be well drained and even then the leaf is likely to be somewhat tough and slightly bitter. One of the main difficulties experienced in raising lettuce in Guam is that of getting the plant to head properly. Observations show that lettuce plants have a tendency to flower more quickly during the rainy season than in the dry season. Mignonette, although a low yielder, is one of the best varieties grown to date for quality. The results of the year's variety test follows:

Variety tests with lettuce.

Test No.	Variety.	Date planted.	Date of first harvest.	Date of last harvest.	Yield per acre.
		1920.	1920.	1920.	<i>Pounds.</i>
1	Mignonette.....	July 10	Aug. 17	Aug. 24	1,050
2	White Paris Cos.....	do.	Aug. 10	Aug. 16	2,550
3	Mignonette.....	Aug. 12	Sept. 23	Oct. 13	1,100
4	Iceberg.....	Aug. 17	Oct. 1	Oct. 8	4,400
5	White Paris Cos.....	do.	Sept. 23	do.	3,412.5
6	Iceberg.....	Sept. 2	Oct. 16	Nov. 17	4,900
7	do.....	Sept. 20	Oct. 27	Nov. 21	2,912.5
8	Mignonette.....	do.	do.	do.	(1)
9	White Paris Cos.....	do.	do.	do.	(1)
10	Mignonette.....	do.	Nov. 2	Dec. 7	3,275
11	Iceberg.....	Oct. 2	Nov. 19	Nov. 29	2,250
12	Mignonette.....	Oct. 16	Dec. 11	.....	1,300
		1921.	1921.	1921.	
13	Mignonette.....	Jan. 11	Feb. 25	Mar. 9	850
14	White Paris Cos.....	do.	do.	Mar. 1	1,650
15	do.....	Jan. 15	Mar. 3	Mar. 22	4,625
16	Iceberg.....	do.	Mar. 10	do.	4,800
17	do.....	Feb. 14	Mar. 28	Apr. 8	2,562.5
18	Mignonette.....	do.	Apr. 1	Apr. 26	2,087.5
19	do.....	Mar. 10	Apr. 22	May 14	525

¹ Failure.

Tomatoes.—An effort is being made to improve the Cristobal variety through selection alone. This variety, seed of which was introduced from the island of Yap, is very prolific, but the fruits are small and rough. This work was seriously interrupted during the year by the presence of a root-rot disease (probably nematode). When the tomatoes were rotated with field crops, especially with legumes, the disease was gradually brought under control. At the close of the year the ninth generation of the selected Cristobal variety was completed. A gradual improvement in quality (smoothness and shape) of fruit is noted. The following table shows the results of the season's tests:

Tests with the selected Cristobal tomato.

Test No.	Generation.	Date planted.	Date of first harvest.	Date of last harvest.	Yield per acre.	
					Number.	Weight.
4	Eighth.....	1920. Oct. 2	1920. Dec. 26	1921. Mar. 29	19,880	<i>Pounds.</i> 1,792.5
5	Ninth.....	1921. Jan. 6	1921. Mar. 7	May 20	79,675	8,482.2
6	Do.....	Jan. 10	Apr. 9	June 28	52,200	5,593.8

Other trials with this variety resulted in failure due to adverse weather conditions.

SEED AND PLANT DISTRIBUTION.

Continued efforts are being made to induce the people of the island to select and save their own seed supply for planting. The members of the boys' and girls' clubs have given a great deal of assistance in this direction and they have also helped to meet the demand in several of the districts by supplying seed material from their own gardens.

During the year a number of fruit plants from the station nursery were distributed to farmers. Nearly all of the citrus plants sent out were budded varieties. Many more economic seeds and plants, but fewer ornamental plants, were distributed this year than during the last fiscal year. Distribution by the station included 4,043 packets of vegetable seeds, 2,767 seedlings and rooted cuttings of ornamentals, 4,362 seedlings and rooted cuttings of economic plants, 8 sacks of Bermuda grass, 435 pounds of leguminous seed, 50 pounds of rice (improved seed), 18 pounds of sorghum, 33 pounds of corn, 1,680 suckers of taro, 13 packets of miscellaneous seed, and 20 sacks of sweet potato cuttings.

COCONUTS (COCOS NUCIFERA).

The coconut trees on the island seem in the main to have recovered from the effects of the 1918 typhoon. The production of copra during the year, however, was below that of last year, due to the decline in prices both at the San Francisco and Manila markets. As a result of the drop in price of copra and the high cost and scarcity of labor, many of the nuts produced were used for human consumption, feed for live stock, and for the extraction of oil by the native method.

Cover crops.—This phase of the work was conducted cooperatively on a plantation at Tarague. Extensive plantings were made during the year with Patani, velvet beans, jack beans, and cowpeas. Of these, Patani beans made the best cover crop, keeping down the weeds and undergrowth very effectively and covering the ground for the longest period of time. Jack beans in many of the areas were destroyed by what appeared to be mosaic disease. At the best, this plant, due to its upright nontrailing manner of growth, does not equal either the Patani or the velvet bean as a cover crop.

Fertilizer tests.—Fertilizer tests are being conducted cooperatively at the coconut plantation at Tarague, plats Nos. 2, 3, and 4 being given applications of 150 pounds of ammonium sulphate, 200 pounds of acid phosphate, and 75 pounds of ammonium sulphate with 100 pounds of acid phosphate per acre, respectively. Plat No. 1 was left to serve as a check. Each plat is 1 acre in size and contains 48 trees. A guard row was left between the plats. When an inspection was made at the close of the year the trees on the various plats seemed to show very little or no difference. Those in plat No. 4, however, had leaves of a greener color than did the others.

REPORT OF THE SUPERINTENDENT OF EXTENSION.

By W. J. GREEN.

INTRODUCTION.

The extension work of the station made very satisfactory progress during the year. The boys' and girls' club work continues to be the most popular and productive of the best results of the three general lines covered by this division. Extension work in Guam presents many problems not encountered in countries of the Temperate Zone. The type of native population, the size and location of the island, and the methods of farming followed are such that many of the methods successfully used elsewhere to disseminate agricultural information would not be successful in Guam. All extension activities of the station have therefore been planned especially to meet the peculiar conditions existing on the island.

Cooperative relations between the extension division and other departments of the station have been pleasantly maintained, all members of the staff taking as much part in extension activities as their duties permitted. Relations with all departments of the island government have continued to be of the best, and the cooperation of the Department of Education with the station has been especially good.

ADULT DEMONSTRATION WORK.

DISTRICT FAIRS.

Much of the adult extension work during the year was carried on in connection with the newly organized district fairs and with the annual Guam Industrial Fair. A series of district fairs was organized and held during the early part of the fiscal year. Eight of these events, including a boys' and girls' club fair, were held at Asan. These fairs, the first of the kind to be held on the island, were all successful and proved to be great factors in arousing a community spirit and an interest in agricultural matters. To stimulate interest in the local fairs, the Guam fair committee offered a trophy banner to the district or districts having the best fair of the season. The judging of the fairs was done according to a fixed scale of points which took into consideration each department of the fair. The prize was won by the Northern Guam Fair, held by the districts of Dededo, Yigo, Barrigada, and Machananao. The standing of the three highest scoring fairs in each of the points considered is given in the following table:

Standing of district fairs for the fiscal year 1921.

Point judged.	Relative value of points.	First.	Second.	Third.
Agriculture.....	200	Inarajan.....	Northern Guam...	Agat.
Live stock.....	200	Northern Guam...	East side.....	Inarajan.
Boys' and girls' clubs.....	100	...do.....	Inarajan.....	Sumay.
Domestic science and arts.....	150	Agat.....	Northern Guam...	Merizo.
Trades and industries.....	100	...do.....	...do.....	Sumay.
Amusements.....	100	Inarajan.....	Sumay.....	Northern Guam.
Fair spirit displayed by people of district.	150	Northern Guam...	Inarajan.....	Umatac.

The Umatac fair.—The first fair of the season was held July 3 at Umatac. Notwithstanding the fact that this district has long been regarded as one of the least progressive on the island, it made a splendid showing at the fair, and its exhibits were the result of careful preparation and selection. Many visitors who took advantage of the transportation offered by the U. S. S. *Napa* and the steamer *Kavara* to view the fairs on the south end of the island expressed their pleasures at the excellent showing made at Umatac.

The Merizo fair.—The second fair was held July 3 at Merizo, which for two successive years has won the first prize in the community contest at the Guam Industrial Fair. The people of this district worked with the determination to have the best fair on the island, and thus maintain their reputation of having the leading agricultural community in Guam. The quality of the exhibits showed the results of this work.

The Inarajan fair.—The third fair was held July 4 at Inarajan. A keen spirit of friendly rivalry had developed between this and the Merizo district.

The Sumay fair.—The fourth fair of the season was held at Sumay on August 7 and 8. The attendance at this fair was exceptionally large. Motor trucks were run between Agaña and Sumay at intervals on both days of the fair to carry the crowds. Among the exhibits were entries in the live-stock department which were especially worthy of mention. Over 225 animals were on exhibition, many of which showed very good quality. The department devoted to street exhibits was very fine, the residents of each of the principal streets in Sumay making a collective display of the products of their farms.

The Agat fair.—This fair, held August 28 and 29, was very nearly spoiled by a threatened typhoon. The wind blew all the afternoon of August 27 and during the night increased in violence until there was every evidence of the beginning of a typhoon. The people placed their exhibits on the morning of August 28, but no visitors came to the fair. On the morning of August 29 the wind died down and the people began to prepare for the crowds which came from Agaña and other parts of the island. Although the rain interfered with the sports, parades, and the business of the concession stands, everyone was well pleased with the showing made. The arrangement of the exhibits at this fair was exceptionally good.

The East Side fair.—This fair was held at Yona on September 11 and 12 by the districts of Talofoto, Sinajana, and Yona. The agricultural products were housed in a specially constructed building of bamboo roofed with coconut leaves. This exhibit hall, which was over 120 feet in length, was well filled. The display of bananas was the principal feature of this department. A building of similar construction over 200 feet in length was erected to shelter the live stock. It proved to be too small for the purpose and many of the cattle had to be tethered outside. The other departments were housed in the school building, which they filled to capacity.

The Northern Guam fair.—This fair was held at Dededo by the districts of Barrigada, Machananao, Yigo, and Dededo on September 25 and 26. Two large temporary buildings were erected to care for the agricultural and live-stock exhibits, and the other depart-

ments were located in the schoolhouse. The exhibits in the live-stock department were especially good, there being more pure-bred and high-grade pigs, poultry, goats, and cattle than at any previous district fairs. Motor trucks were run from Barrigada and Yigo to carry products for exhibition and from Agaña to carry visitors. Hundreds of persons from all parts of the island visited this fair, which proved to be the best of the season.

The following table gives the number of entries in the various departments at the district fairs:

Number and kind of exhibits at the district fairs.

Department.	Umatac fair.	Merizo fair.	Inarajan fair.	Sumay fair.	Agat fair.	East Side fair (Yona).	Northern Guam (Dededo).	Total.
Agriculture.....	138	171	415	275	405	341	483	2,233
Live stock.....	100	94	138	229	210	120	595	1,486
Boys' and girls' clubs.	52	47	69	85	28	37	41	359
Trades and industries	39	33	40	63	104	40	137	456
Domestic science.....	77	81	73	143	147	75	190	786
Domestic arts.....	65	97	117	153	214	101	111	858
Total.....	471	523	852	948	1,108	714	1,557	6,178

THE GUAM INDUSTRIAL FAIR.

The fifth Guam Industrial Fair was held on February 3, 4, and 5, 1921. All members of the station staff served on the fair committee. The exhibits were almost equal in quantity and were superior in quality to those of last year, notwithstanding the difficulty experienced in getting transportation for products from outlying districts and the fact that the crop season was later than usual. The exhibits in the departments in which the station was interested numbered 7 for the community, 10 for school gardens, 463 for agriculture, 120 cattle, 30 carabao, 25 pigs, 23 goats, 86 poultry, and for the boys' and girls' club, 519 for crops, 17 pigs, and 38 for poultry.

The exhibits made in the general agricultural department for the most part showed the results of more careful selection and preparation than was true of former fairs. The 443 entries made in this department, together with the live-stock exhibits, clearly showed the possibilities of making Guam self-supporting as far as food is concerned.

The entries in the live-stock department showed a marked increase in quantity over those of the previous year. The outstanding feature of this part of the fair was the large number of animals of improved breeding. The increase of these animals over those of last year was especially noticeable in the cattle, swine, and poultry classes, where grade Ayrshires, grade and pure-bred Berkshires, and Rhode Island Reds were much in evidence. This department of the fair was supervised by the animal husbandry department of the station.

As usual a large part of the interest was centered about the community contests. Each district entering the contest was given a 15-foot space in the agricultural building in which to display its products. These exhibits were separate and distinct from the gen-

eral agricultural entries. Each community display was judged according to a score card which took into consideration the artistic arrangement and educational value of the exhibit as well as the quantity and quality of products.

The community exhibits as a whole showed the results of better care in selecting and arranging the products than was the case at previous fairs. This improvement was doubtless due to a large extent to the circulation among the people of photographs of similar exhibits in the States, to personal conferences with the leaders of the various districts, and to the issuing of a circular giving instructions for preparing a community exhibit. The following table gives the scores made by each district in the various points considered by the judges:

District scores in community contests of the fifth Guam Industrial Fair.

Exhibit.	Points.	Districts.						
		Umatac.	Merizo.	Agat.	Inarajan.	Yigo.	Yona.	Sinajana.
Corn in the ear.....	50	37.5	47.5	20.0	37.5	6.5	22.5	20.0
Corn, shelled.....	50	49.0	25.0	20.0	10.0	7.5	5.0	10.0
Coconuts, husked and unhusked.....	50	27.5	49.0	49.5	15.0	.....	17.5	.....
Coconut products.....	50	40.0	50.0	10.0	25.0	17.5	11.0	4.5
Native grasses and forage crops.....	25	19.0	25.0	5.5	2.0	.....	13.5	.....
Introduced grasses and forage crops.....	50	17.0	17.0	.....	.....	.....	17.0	.....
Squash, pumpkins, and melons.....	50	5.0	32.5	25.0	15.0	15.0	13.5	10.0
Other vegetables.....	100	77.5	33.0	42.0	55.0	55.0	4.0	22.0
Root crops.....	75	66.5	55.0	67.5	65.0	50.0	15.0	35.0
Fruits.....	125	99.5	110.0	117.5	85.0	82.5	62.5	30.0
Leguminous crops (cow-peas, mungo, etc.)....	50	40.0	17.5	27.5	17.5	35.0	.....	.....
Natural resources.....	75	60.0	75.0	52.5	52.5	5.0	.....	.....
Other crops.....	100	75.0	92.5	95.0	55.0	75.0	30.0	17.5
Artistic arrangement and educational value.	150	145.0	127.0	120.0	127.5	62.5	82.5	50.0
Total score.....	100	758.5	756.5	652.0	562.0	411.5	294.0	199.0

EXTENSION WORK WITH CROPS.

The extension work with crops was again directed toward the selection and planting of better seed, better methods of seed-bed preparation and cultivation, and the distribution of seed of varieties which have been found by the station to be adapted to Guam conditions.

As there are no seed merchants on the island, the people depend to a large extent upon the station for their supply of seeds, especially for vegetable seeds for planting. An effort was made during the year to have the people save the seed of their crops, and instructions and directions for seed selection and storing were given.

IMPROVED MACHINERY.

Efforts were made throughout the year to encourage the use of improved farming machinery. All of the plows and practically all of the cultivators that were shipped in by the island government for sale to native farmers were disposed of. Many of these implements went to

districts where they had not been used previously. Merizo district now has the distinction of preparing practically all the land with plows and doing a large part of the cultivating with cultivators.

The first farm tractor was brought to the island during the year. This machine is one of the popular small tractors using the caterpillar type of traction. It was tried out at the station and adjusted for use for the owner, and formed the station's part of the parade on the opening day of the Guam Industrial Fair. The machine is now in use on a plantation at Togehe, where there are extensive plantings of sugar cane. In addition to being used for field work the tractor is also used to run a small sugar mill. It has created considerable interest in Guam, and several of the planters who have comparatively large holdings are considering the purchase of tractors. The tractor has a limited field in Guam because most of the farms are very small in area. It, however, has a place on the large plantations.

BETTER SIRES—BETTER STOCK CAMPAIGN.

During the year arrangements were made with the Bureau of Animal Industry, United States Department of Agriculture, to extend the "Better Sires—Better Stock" campaign, as conducted in the States, to Guam. It was thought that a campaign of this nature would serve not only to stimulate and maintain interest in the use of improved live stock but also as an excellent follow-up of the importations of pure-bred swine and poultry made the previous year.

Considerable publicity was given this campaign through posters, articles in the local papers, and by meetings and personal conference. A local representative was appointed for each district to systematize matters. All the work as far as possible was done through these representatives, who, being leaders in their districts, were selected because of their interest in agricultural matters.

It is rather difficult for the Guam farmer to qualify for enrollment because he must agree to breed all of his animals kept for breeding purposes to pure-bred sires, and this he hesitates to do. Six enrollments, however, have been made and many persons are desirous of securing pure-bred sires and becoming eligible for enrollment. The main difficulty at present does not lie in getting the people interested in better stock, but in letting them know where they can purchase pure-bred or high-grade animals. The supply of this kind of stock is still limited, and the many difficulties make importations by private individuals almost impossible. As time goes on and improved animals are raised from the foundation stock introduced into the islands by the station and by the island government, it is hoped that this condition will be remedied.

SCHOOL GARDENS.

School gardens were maintained in connection with each of the 11 outlying schools of the island. This work is conducted cooperatively by the experiment station and the Department of Education of the island government. The supervision of the planting and care of the gardens is a part of the extension work of the station. Gardening continues to be a required part of the course of study in

the outlying districts. One-half day each week is devoted to working in the garden under the direction of a teacher. This work is done by the boys only. The girls spend the same period in sewing, basketry, or work of a similar nature.

An attempt was made to have all school gardens save enough seed for their own use and if possible for the use of the farmers of the district. (Pl. V, Fig. 1.) Nearly all of the schools were able to save bean, watermelon, pumpkin, squash, cucumber, eggplant, tomato, and pepper seed sufficient for their own use and for distribution, but the majority had to depend on the station for their supply of radish, lettuce, and turnip seed.

Two seasons' work has been completed and a third planting has been made. Each garden supervisor is required to make a report at the end of each season on the work done in his garden. Special blanks have been printed for this purpose. Each report includes a list of the vegetables planted, amount planted, dates of planting and harvesting, yields, values, and general information regarding the care of the garden.

During the early part of the fiscal year a garden was started in connection with the new school at Talofofu. This school is on the east side of the island in a district that can be reached only by foot. It has great agricultural possibilities, but has remained comparatively undeveloped because of the difficult means of communication with other parts of the island.

At the beginning of the first season a visit was made to the new school for the purpose of getting the garden started. A supply of seed was taken along, and instructions for planting and cultivating were given. Most of the children were unfamiliar with many of the vegetables. Not one had ever seen lettuce, or had any idea how to care for it or use it. The same was true in a lesser degree of other American vegetables. On account of the excessive rains the first garden was a failure. The garden planted at the beginning of the second season, however, was a success and served to acquaint not only the pupils but also the older people of the district with the proper methods of planting and caring for a garden.

THE UNITED STATES SCHOOL GARDEN ARMY.

All boys working in the school gardens were again enrolled in companies of the United States School Garden Army, as conducted by the United States Bureau of Education, and were supplied with insignia. The fact that they belong to a national organization serves to stimulate the pupils to greater interest in their work.

EXHIBITS AT GUAM INDUSTRIAL FAIR.

At the fifth Guam Industrial Fair, held February 3 to 5, each school was given space in the educational department for a display of the product of its garden. All schools with the exception of Sumay made very creditable exhibits. Sumay made no display because the garden supervisor was sick at the time. The complete baseball outfit offered by the superintendent of schools to the district having the

best exhibit created a spirit of keen rivalry among the boys of the various schools. The prize was won by the Yona district.

BOYS AND GIRLS' CLUB WORK.

Boys and girls' agricultural club work continues to be the most popular phase of extension, and is proving very beneficial to the agriculture of the island. The younger generation is much more willing to learn than the older folks who, as a rule, are slow to adopt new ideas.

The club work is carried on in close cooperation with the schools of the island. Club work is required in the schools of all outlying districts. The membership of the club, however, is not limited to school children, and any boy or girl under 19 years of age may enroll, provided he or she agrees to follow instructions as closely as possible.

The club year is divided into two seasons to correspond to the two general crop seasons. The first period ended October 1, 1920, and the second March 15, 1921. These were the third and fourth seasons for club work in Guam. The dividing of the year into two periods, each complete in itself, enables the club member to keep employed practically all the time and interested in his work.

ORGANIZATION.

Club activities supervised.—The club activities supervised during the first season were corn, bean, taro, copra, pig, and poultry. At the beginning of the second season the taro club was changed to the root-crop club, and a new activity, the garden club, was organized. These activities are considered essential to meet the agricultural needs of the island.

Local club organizations.—All members in each district are organized into a local club under the direction of a supervisor, usually the principal of the school, appointed by the superintendent of extension, with the advice of the superintendent of schools. Eleven of these local organizations were supervised during the year, including the newly organized club at Talofoyo. Each supervisor is responsible for the work in his district. He is expected to hold a meeting of the members of his club at least once every two weeks and to make personal visits to each club member's home at regular intervals. As far as possible all club work is done through the supervisor. Semimonthly conferences with supervisors from the northern part of the island and monthly meetings of all supervisors and their assistants were held at Agaña during the year, reports on the progress of the work in each district were received, and instructions and suggestions for the progress of the work were given.

INSTRUCTIONS.

The practice of issuing printed instructions in the form of leaflets for each club activity was continued during the months of July, August, and September. Thirteen of these leaflets were printed. The publication of instruction leaflets was discontinued November 1, being replaced by the Guam Club Member, a four-page paper,

9 by 12 inches. It contains timely instructions, news items of club work, and letters and stories by club members. It has been published monthly, with the exception of December and January, when the numbers were combined. This publication is an excellent means of keeping the members interested in their work. The printing is done by the Navy print shop, the only one on the island, and is paid for by the Department of Education of the island government.

In addition to the above, three special notices were published and distributed to club members. Extension Circular 1, Plans for Boys' and Girls' Agricultural Clubs for 1921, was prepared and published locally. Extension Circular 2, The Home Garden for Club Members, by Glen Briggs, was printed in Washington. Two mimeographed circulars giving in detail the results of the club work for each season were issued in limited quantities. Score cards for corn, beans, and copra were published, together with instructions for scoring. Instructions for judging swine and cattle, containing a list of the points to be considered, were issued, and copies of Farmers' Bulletins 1106, Incubation of Hens' Eggs; 1110, Lice, Mites, and Cleanliness; and 1113, Poultry Houses, and Department Circular 13, Brood Coops and Appliances, were distributed to poultry club members.

The printed instructions were supplemented by personal visits to the homes of the club members. The usual practice is to take the supervisor and all the members of the local club to the home of each member and inspect his work. The merits of the work are discussed and suggestions for improving it are given. In this way each member can see how his work compares with that of the other members.

REPORTS AND STORIES.

Each club member is required to keep a record of his work and make a report to the supervisor at the end of the season. New report blanks, suited to local conditions, were prepared and printed for this purpose. Each report is accompanied by a story of the season's work. The best of these stories are printed in the Guam Club Member. Due to the close personal supervision given this work, there was an unusually large number of members making reports. For the season ending October 1, 1920, 89.9 per cent of the boys and girls turned in reports, and 88.6 per cent for the season ending March 1, 1921.

EXHIBITS AT DISTRICT AND CLUB FAIRS.

As already indicated, club exhibits formed an important part of the series of district fairs that were held during the early part of the fiscal year. In most cases the entries made by the club members showed that an effort had been made to put into practice the instructions given for selecting and preparing exhibits. In the district of Asan the club members held a fair of their own after the adults had decided not to have one. This contest was the first distinctly club fair to be held on the island. In all, 430 individual entries were made at these fairs. The number made in each club activity at each event is given in the following table.

Boys' and girls' club exhibits at the district fairs held in Guam during the fiscal year 1921.¹

District.	Club activity and number of exhibits.						
	Corn.	Bean.	Taro.	Copra.	Pig.	Poultry.	Total.
Agat.....				2	14	12	28
Asan.....	7	16	2	8	17	21	71
Dededo.....	2	4	2	5	7	5	25
Inarajan.....	33	7	4	6	6	13	69
Merizo.....	14	3	1	5	3	21	47
Sumay.....	38	18	3	4	8	14	85
Talofofo.....		5	1				6
Umatac.....	3	14	4	7	9	15	52
Yigo.....	3	2		7		4	16
Yona.....	6	2			10	13	31
Total.....	106	71	17	44	74	118	430
Number of members exhibiting.....	75	44	13	25	65	106	328
Percentage of members exhibiting.....	51.7	32.3	15.6	62.5	58	45.9	43.9

¹ Including the Asan fair.

EXHIBITS AT THE GUAM INDUSTRIAL FAIR.

The club members made a very good showing at the fifth Guam Industrial Fair. (Pl. V, Fig. 2.) The total number of entries was 519 in the crop club department, which was 56 more than the total number in the general agricultural display. These exhibits excelled in quality those of the previous year. Owing to transportation difficulties, the number of entries in the pig and poultry club sections was not as large as that of last year. The quality of animals and fowls, however, was much better. In the pig club there were 17 entries, the larger number of which were Berkshires. At the previous Guam Industrial Fair all the animals shown in the club department were natives. In the poultry club 38 entries were made, a large percentage of which were trios of Rhode Island Reds. Last year only one member had chickens of this breed on display. The total number of entries made in all club activities was 574. The number made by each district is given in the following table:

Boys' and girls' clubs exhibits at the Guam Industrial Fair for the fiscal year 1921.

District.	Club activity and number of exhibits.							
	Corn.	Bean.	Garden.	Root crop.	Copra.	Pig.	Poultry.	Total.
Agaña.....	1	9	12	9	3	1	4	39
Agat.....					6		6	12
Asan.....	9	29	2	12	4	2	4	62
Dededo.....	5	16	21	2	1	3	2	50
Inarajan.....	32	14	6	8	6		2	68
Merizo.....	16	21	4	17	19	3	5	85
Piti.....						1		1
Sumay.....	7	8	2	14	12		2	45
Talofofo.....	10	12	10	9	3		1	45
Umatac.....	3	8	1	19	7	3	7	48
Yigo.....		4	2	4	4	1	2	17
Yona.....	18	7	28	40	3	3	3	102
Total.....	101	128	88	134	68	17	38	574
Number of members exhibiting.....	65	51	34	68	42	16	32	308
Percentage of members exhibiting.....	48.1	26.1	27.8	36.2	40	10.2	10.1	23.8

LIVE-STOCK AND CROP-JUDGING CONTESTS.

A new feature of the Guam Industrial Fair this year was the judging contests for club members. Two contests were held, one in judging live stock and the other in judging crops. All local clubs were allowed to enter a team of three members each for the contests. In the stock-judging contests, which were really a live-stock and poultry contest combined, the teams were required to judge a class each of native cows, Berkshire pigs, and Rhode Island Red chickens. First place was won by the Umatac team, second by Asan, and third by Yigo. Each team entered in the crop-judging contest placed four samples each of corn, beans, and copra. Umatac again took first place; Yigo, second; and the Yona team made up of girls, third. In each contest the participants were required to give their placings and their reasons for their choice. Fifty credits were allowed on each of these points. Considering the fact that none of the club members or supervisors had ever heard of a judging contest before, the contestants did very creditable work.

In order that the members and supervisors might receive the proper training in this work, score cards for corn, beans, and copra were drawn up and mimeographed. Leaflets giving the points to be considered in judging cattle and swine were also issued. These score cards were first explained to the supervisors who in turn gave their members as much training as possible before selecting their teams. From the interest taken in the work it would seem that such contests could be made a valuable part of the club work of Guam.

CORN CLUB.

Each member of the corn club is required to grow at least one-tenth acre of corn according to instructions. The enrollment for the first season numbered 145, which was increased to 210 during the second half of the year. At the end of the first period 132 members or 91 per cent completed their work and made reports. At the end of the season, 200 members or 95.2 per cent made reports.

The results of the two seasons' work show that the club members are learning many of the fundamental principles of better farming. The common practice among the natives has been to prepare the land for planting by clearing the weeds and grass with a fosiño and to plant the seed in holes made in the hard ground. During the last part of the year 34.5 per cent of the club members reported having used plows to prepare a seed bed for planting. A number of the others would have used plows had they been available. Another common practice is to plant the corn too thickly, it being the impression that the greater the number of stalks to the hill the higher will be the yield. Club members were instructed to thin their corn to three stalks to the hill. Of the 210 members reporting at the end of the year, 146 followed these instructions. The others grew corn that did not need thinning.

Seed selection was also emphasized, with the result that 96 per cent of the members reported having saved seed for planting.



FIG. 1.—PITI SCHOOL GARDEN.



FIG. 2.—CROP CLUB EXHIBITS AT THE 1921 GUAM FAIR.



FIG. 1.—CLUB MEMBERS WITH PIGS WON IN A CONTEST.



FIG. 2.—POULTRY CLUB GIRL.

BEAN CLUB.

Members of the bean club are required to grow a plat of beans measuring at least 500 square feet. Most of them, however, cultivated an area larger than this, planting Kentucky Wonder and Lima beans, cowpeas, mungo beans, and various varieties of native beans. Seed-bed preparation, planting, cultivation, and seed selection were stressed with good results.

The enrollment in the bean club for the season ending October 1, 1920, was 136. Of this number 121, or 88.9 per cent, made reports. For the season ending March 15, 1921, the enrollment was increased to 192, of whom 177, or 92.2 per cent, completed their work and made reports.

GARDEN CLUB.

This club was started on November 1, 1920, which permitted of the completion of only one season's work. This activity was added to the work already in progress because the growing of a variety of vegetables of good quality is an important factor in the work of trying to make the island self-supporting. Each boy and girl taking up this work is required to grow at least three varieties of vegetables on a plat that is not less than 500 square feet in area. This new club proved to be very popular, and promises to be one of the largest organized. The enrollment was 122. Ninety-four, or 77 per cent, of these members completed the season's work and made reports.

TARO AND ROOT CROP CLUBS.

According to the rules of the taro club each member was required to grow a plat measuring at least 500 square feet. On November 1, 1920, this activity was changed to the root crop club and the rules amended so that cassava, sweet potatoes, yams, arrowroot, and edible canna might be grown as well as taro. As only certain localities are adapted to the growing of good taro, the club as now conducted interests more persons than formerly. This fact is shown very clearly by the enrollment which increased from 83 to 188 from the first to the second session. The number of members reporting for the first season was 72, and for the second, 163.

COPRA CLUB.

In the copra club each member is required to care for at least 10 coconut trees and make copra from the nuts obtained. Many of the boys cared for more than the required number, some of them having plantations of over 100 trees. Proper methods of caring for the trees, growing cover crops, gathering and storing the nuts, and making copra are the main points emphasized in this work. The enrollment for the season ending October 1, 1920, was 40. Thirty-five of these members made reports. The enrollment for the season ending March 15, 1921, was 103, and of these 97 made reports.

PIG CLUB.

Each boy and girl belonging to this club is required to own at least one pig and care for it according to instructions. Many of the members own female pigs with which they start a herd of their own. In all swine improvement work in Guam only one breed, the Berkshire, is being used. It is hoped in time to have the progeny of this breed scattered throughout the island. The number of club members owning pure-bred and high-grade animals was materially increased during the year. (Pl. VI, Fig. 1.) All members who own native pigs are encouraged to breed them to Berkshire boars so as to get a start in raising improved stock. The club members have made excellent progress in their methods of caring for pigs. Practically none of them now follows the native method of tethering each animal to a stake or a tree by one leg, and nearly all of them realize the importance of having sanitary quarters in which to keep the animals, as well as the need of proper feeds.

The enrollment in the pig club was 112 for the first season and 157 for the second season. At the end of the first period 98 members made reports and at the end of the second period 137 made reports.

POULTRY CLUB.

This club activity continues to be the most popular of all with both boys and girls. Each member is required to raise chickens from at least one setting of eggs. Most of the members, however, raise more than the required number. Many of the older members who have been in the work since it was first started now own fair-sized flocks. All members are encouraged to raise chickens of an improved breed. They are standardizing on Rhode Island Reds. During the year the practice of distributing Rhode Island Red eggs to worthy club members for setting purposes was started. (Pl. VI, Fig. 2.) These eggs, which were taken from pure-bred and graded stock at the station's breeding pens, were given to club members who had made progress in their work with the understanding that an equal number of eggs should be given to some other member when the chickens hatched from the original eggs began to lay. Records kept by the poultry department show that 46 settings of eggs were distributed to club members in this manner.

During the first season a total of 231 boys and girls became members of the poultry club. Of this number 204 made reports. During the second season the enrollment was increased to 317, of which number 277 completed their work and made reports.

SUMMARY OF WORK DONE BY ALL CLUBS.

In all club activities a marked increase was noticed in the work of the second season over that of the first. The total enrollment increased from 747 to 1,291. The total number completing the work and making reports increased from 662 to 1,145. The per cent. of members reporting, however, showed a slight increase, from 89.9 to 88.6 per cent. The total value of all products for the first season was \$8,296.07 and for the second season \$19,209.08.

DISTRICT GRADES IN CLUB WORK.

In order that it might know how its work compared with that of every other district each district was graded in each club activity according to a certain scale of points, which were drawn up so that the small districts could compete with the larger ones. The standing of each district is published at the end of each season. This plan seems to stimulate interest in the work, and each district tries to excel the other districts.

Club score cards.—The score cards used in grading the work of each local club were as follows:

Score card for boys' and girls' clubs.

	Points for corn, bean, garden, and root crop clubs.	Points for copra club.	Points for pig and poultry club.
Number of members enrolled.....	20	25	25
Percentage of members making reports.....	20	25	25
Average yield per member.....	20	.....	.....
Exhibits at district fair.....	20	25	25
Quality of work done by members.....	20	25	25
Total.....	100	100	100

Corn club.—In the corn club, competition for the first place was very keen among the districts of Inarajan, Merizo, and Sumay. Inarajan made the best grade of all during the season ending October 1, 1920, and Merizo scored highest during the season ending March 15, 1921.

Bean club.—The competition for first place in this activity was strongest between Merizo and Sumay, the former taking the highest score during the first season and the latter during the second.

Garden club.—As this club was started on November 1, 1920, grades were given for one season only. Merizo made the highest score, followed by Sumay, with Inarajan, Yona, and Yigo running very closely for third place.

Taro and root crop clubs.—During the first season the best grades in the taro club were made by Sumay and Umatac. During the second part of the year, after this activity had been changed to the root-crop club, the highest scores were made by Merizo and Yona.

Copra club.—In this club Merizo made the highest grades for both seasons. Inarajan took second place during the first, and Sumay during the second part of the year.

Pig club.—First place in this club was taken by Asan and second by Agat during the first part of the year. During the latter part of the year the highest score was made by Merizo, followed by Umatac.

Poultry club.—Merizo made the highest score in this activity during both seasons of the year. Asan took second place during the first period and Sumay during the second.

Standing of districts in all club activities.—The grade for each district in all club activities is found by dividing the total of all

grades by seven, the number of activities. It is considered a great honor to have the highest standing in all clubs, and competition between the districts for first place is very keen. During the first season the highest honors were won by Sumay, followed by Inarajan and Merizo. During the second season first place was won by Merizo, with Sumay and Yona coming second and third. The rise of the last-mentioned district from seventh to third place is worthy of mention. The standing of all districts in all phases of club work is given in the following table:

Standing of districts in all club activities.

Rank.	First season.		Second season.	
	District.	Grade.	District.	Grade.
1	Sumay.....	82.9	Merizo.....	82.4
2	Inarajan.....	77.2	Sumay.....	77.5
3	Merizo.....	76.0	Yona.....	68.5
4	Asan.....	74.0	Umatac.....	68.2
5	Umatac.....	73.9	Inarajan.....	66.8
6	Dededo.....	63.3	Asan.....	66.3
7	Yona.....	44.6	Yigo.....	64.1
8	Yigo.....	43.5	Dededo.....	63.0
9	Agat.....	35.9	Talofofo.....	55.3
10	Talofofo.....	32.4	Agat.....	24.7
11	Piti.....	16.5	Piti.....	11.0

GROWTH OF CLUB WORK.

Since its organization in May, 1919, club work in Guam has made a steady growth in all of its phases. The enrollment has increased from 560 to 1,291, the per cent of members reporting from 61.4 to 88.6, and the value of the products from \$1,402.09 to \$19,209.08. The following table shows the enrollment, number and per cent of members reporting, exhibits at fairs, and the value of club products for the four seasons during which the work has been in progress:

Growth of club work in two years.

Season ending—	Total enrollments.	Number of members reporting.	Per cent of members reporting.	Exhibits at fairs.	Value of club products.
Nov. 1, 1919.....	560	340	61.4	.....	\$1,402.09
Mar. 15, 1920.....	545	439	80.1	376	3,513.63
Oct. 1, 1920.....	747	662	89.9	430	8,296.07
Mar. 15, 1921.....	1,291	1,145	88.6	547	19,209.08

RESULTS OF CLUB WORK.

Some of the results of the club work in Guam are already apparent. In practically every part of the island club members are taking the lead in agricultural improvement. The first pig of improved breeding seen in the district of Umatac was owned by a club member, and there is now a popular demand for this kind of stock in the community. The first plow in the district of Yigo was owned by a corn club member.

During the past season a number of farmers in that locality purchased these implements. The first cultivator in Inarajan was used by a club member. The first chickens of improved breeding in many districts were owned by club members. In other localities club members were the first to use drying racks for making copra. New varieties of seeds have been introduced by club members into many communities. The boys and girls are not only learning lessons that will be of value to them later in life, but they are also teaching the older folks by demonstrating the proper methods of doing things. Years are required to see the results of work of this kind, but there is very little doubt that the boys' and girls' clubs will prove to be the most valuable line of extension work in Guam.

ACKNOWLEDGMENTS.

In closing the report of the junior extension work, the writer wishes to express his appreciation of the cooperation of the schools of the island, and especially of the cooperation of Capt. A. W. Stone, United States Navy, head of the Department of Education, and J. Schnabel, superintendent of schools, who have assisted in encouraging the development of agriculture, the only resource of the island.

METEOROLOGICAL OBSERVATIONS, 1921.

By P. NELSON, *Assistant.*

The weather conditions of the year may be considered as having been normal. No disastrous storms visited the island. The only period of stormy weather occurred during August at a time of heavy rains, when little planting was being done, and caused practically no damage to the crops. It would appear from the record of the number of days of precipitation from January to June that the so-called "dry" season was rather wet. Most of the rains falling during this period, however, were showers and in the aggregate did not amount to much and were not sufficient for planting operations. In many localities the drought necessitated the replanting of crops several times. Of the 109 earthquakes recorded by the seismograph at Agaña, none was severe enough to cause any damage. A total eclipse of the moon was observed October 27.

Atmospheric pressure.—The barometer was fairly steady throughout the year, the only considerable variations occurring during August and December. At 11.30 a. m. August 27 the barometer commenced falling gradually, continuing to do so until 4 a. m. of August 28, when it reached its lowest reading, 29.269 inches. From that time until 4 p. m. of August 29 it rose rapidly until it reached normal. The period of low barometer was accompanied by heavy rains and squally weather. From December 21 to December 26 the barometer oscillated from 29.576 to 29.855, the former being the lowest reading for the month and the latter the highest. During this interval a heavy surf was observed to roll in, although for no apparent

reason, as the velocity of the wind had not been above the average. The heavy surf and variable barometer would indicate that a severe storm had been raging in the vicinity. The mean of the daily readings for the year was 29.746 inches, this being the lowest for the past four years. The maximum for the year, 29.866, was observed November 7, and the minimum, 29.269, August 28.

Temperature.—November, which had a mean temperature of 83.02° F., was the hottest month of the year, and July, which had a mean of 81.11° F., proved to be the coolest. The mean of the daily readings for the year was 81.88° F., which was slightly higher than the record of the previous year. The averages of the monthly means were, maximum, 87.38° F., and minimum, 76.37° F. The maximum reading for the year was 93° F., recorded April 29, and the minimum 71° F., recorded December 1. The greatest daily range in temperature was 18.5° F., which was noted April 29, and the least daily range of 2.5° F. was recorded August 13. A temperature of 90° F. or over was observed on 48 days during the year, this being just one-half the number of days of this temperature of the previous year. The record of the dry and wet bulb thermometers is incomplete due to the accidental breaking of the instruments.

Rainfall.—This year the total precipitation of 111.41 inches was the highest recorded at the station for the past four years. Rainfall was recorded on 273 days, this being about equal to the previous year. July to December again proved to be the wettest months, the total rainfall amounting to 88.18 inches on 152 days. From January to June 23.23 inches of rain was recorded on 121 days. July with a total of 25.48 inches was the wettest month, while February proved to be the driest with 1.48 inches. Rain fell during every month of the year, October with 29 days of rainfall being the highest, and May with 16 days the lowest. The maximum rainfall of the year for a 24-hour period was 5.9 inches, which occurred August 28. During the year there were 187 clear days, 98 partly cloudy, and 68 cloudy (exclusive of 12 days on which no records were taken). Rainfall was observed on 117 clear days, 90 partly cloudy, and 66 cloudy days.

Velocity and direction of wind.—The prevailing direction of the wind was northeast, with 33 per cent of the total, and was predominant during October, December, January, February, and April. East had the next highest with 31 per cent and prevailed in November, March, and June. During the three wettest months, July, August, and September, variable winds were encountered ranging from southeast to west, with southeast the prevailing wind during July and west the predominating direction during August and September. The average of the monthly mean velocity was 147.5 miles daily average and 6.14 miles hourly average. The maximum velocity for a 24-hour period occurred December 30 with 417.8 miles.

The following table gives the condensed meteorological data for the year.

Condensed meteorological data for the fiscal year 1921.

Month.	Temperature.					Total precipitation.	Wind.	
	Maximum.	Minimum.	Mean maximum.	Mean minimum.	Monthly mean.		Prevailing direction.	Average hourly velocity.
1920.	° F.	° F.	° F.	° F.	° F.	Inches.		Miles.
July.....	91.0	73.0	86.07	76.16	81.11	25.48	Southeast.....	3.74
August.....	89.0	72.5	85.56	76.75	81.15	21.31	West.....	5.82
September.....	91.0	74.5	87.06	76.71	81.88	12.19	.....do.....	3.42
October.....	91.0	75.0	87.50	76.58	82.04	16.86	Northeast.....	4.31
November.....	91.0	74.0	88.60	77.45	83.02	3.86	East.....	6.54
December.....	90.0	71.0	86.82	77.00	81.91	8.48	Northeast.....	8.13
1921.								
January.....	89.0	74.0	86.46	75.61	81.04	4.23	Northeast.....	9.35
February.....	89.5	73.0	87.40	74.77	81.08	1.48	.....do.....	7.06
March.....	90.5	73.0	87.98	76.67	81.82	3.50	East.....	7.87
April.....	93.0	74.0	87.63	76.50	82.06	6.80	Northeast.....	7.68
May.....	91.0	71.5	88.86	76.15	82.50	2.44	Southeast.....	4.48
June.....	90.0	74.0	88.82	77.12	82.97	4.78	East.....	5.31
						111.41		6.14

The following table gives a comparison of the rainfall by months for a period of four years:

Comparison of the rainfall by months from four years' record.

Month.	1917-18	1918-19	1919-20	1920-21	Average for four years.
	Inches.	Inches.	Inches.	Inches.	Inches.
July.....	8.95	30.53	7.58	25.48	18.14
August.....	15.13	12.27	23.65	21.31	18.09
September.....	20.94	16.90	14.13	12.19	16.04
October.....	11.71	12.60	6.10	16.86	11.81
November.....	6.29	6.26	8.52	3.86	6.24
December.....	2.58	3.05	5.23	8.48	4.84
January.....	7.62	1.65	2.01	4.23	3.87
February.....	8.53	.91	1.92	1.48	3.21
March.....	2.67	1.42	6.00	3.50	3.39
April.....	3.65	.61	4.34	6.80	3.85
May.....	5.10	1.03	6.09	2.44	3.66
June.....	8.05	8.54	5.32	4.78	6.67
Total.....	101.22	95.77	90.89	111.41	99.82

